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On the Principle of Edges

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Ecotones—Toward a New Edgeucation

by Brock Dolman

An edge is only as productive as the adjacent interior is intact. As a corollary to the permaculture principle of maximizing edge in designs, I would like to put forth a new, explicitly stated principle of maximizing interior.

I am interested in examining some theoretical origins of edge and how the idea of edge is so often oversimplified that it does not reflect the state of the world.

Permaculture considers itself to be based fundamentally in the science of ecology. In recent decades, academic studies, especially within the disciplines of island biogeography and conservation biology, have refined and better articulated the dynamics of fragmentation, edge and edge effects. Juxtaposed with our positive perception edges, a large body of research points to significant overall negative impacts from edge effects on biodiversity.

Globally, we live with many tattered, disjunct pieces of remnant habitat islands amidst a diverse sea of human-altered landscapes. (A remnant is any stand of native vegetation that remains after most or all of the indigenous vegetation has been removed.) Human development on the planet has actually maximized edge in our terrestrial ecosystems. The result of our assault on native vegetation communities is a significant loss of contiguous, intact habitats that contain ecologically functional interior characteristics. Our landscape matrix is dominated by recently created habitat remnants that contain a significant amount of edge, yet do not function like the co-evolved natural ecotones that initially gave rise to the idea of edge.

Ecotone, Interior, and Edge

At the landscape level, the natural interface between any two biotic communities often forms what is considered a third type of community called an "ecotone". According to *The American Heritage Dictionary*, an ecotone is:

"an ecological community of mixed vegetation formed by the overlapping of adjoining communities."

Ecotone is derived from two Greek words—*oikos* meaning house and *tonos* meaning ten-

sion. The term ecotone is based implicitly upon the interrelationships of organisms in community and fluxes of energy. Ecotones exist in a state of dynamic tension between the two houses or habitats, forming a third more diverse house.

An ecotone is only as productive as the contributing communities are ecologically sound.

Permaculture teaches the concept of ecotone using the term "edge". *The Designers Manual* defines edge as:

"the junction/zone of mixing or effect that lies between two media or landscape forms.... Edges are normally richer in species than the contributing media themselves."

This definition of edge includes both a physical place or structural component (e.g., junction/zone, landscape forms) and also the idea of effect, implying some form of energetic relationship. The *oikos* of place interfacing with the *tonos* of relationship. It is often taught in design courses and oft repeated by students that a good permaculture design will contain the maximum amount of edge to provide for the maximal species richness and productivity. The theory holds that an increase in edge will enhance the yield of the system and maintain the "stability and resilience" as observed in natural ecosystems.

In today's world, finding a definition for interior habitat is almost as difficult as actually finding any functional interior habitat itself. At the heart of the idea of interior habitat is continuity of structure and implication. The diverse tall-grass prairies of the mid-west were a vast representation of structural continuity that gave rise to the most populous mega-herd of ungulates on the planet, the American Bison. The interior of a 2,000-year-old forest is a very highly productive, stable and resilient habitat. Consider the fact that

old-growth redwood communities of coastal California have the highest amount of standing fixed carbon of any terrestrial habitat in the world. Fixed carbon is a significantly important energy commodity in a sustainable system.

The idea of productivity needs to be considered relative to the dimension of time, and the design of systems must look to mature perennial habitats as the ultimate representation of efficient and productive solar energy fixation. Interior habitats are characterized by a differential level of system stability and maturity that support the energetic dynamism observed at ecotones. These interior habitats come together to form the third habitat. For this reason, we do a disservice to the ecosystem, if we focus on maximizing edge without recognizing what the interior habitat is contributing. Interior continuity and maturity do not mean that interior habitats lack dynamism, diversity or overall productivity.

Edge and Harmonics

Two examples of permaculture patterning that invoke the productivity of edge effects are:

- edge cropping and
- pond designs that increase edge (more surface area per unit of volume) by including wavy, serpentine forms.

Fractal tessellations along coastlines are similar patterns that more appropriately describe harmonics and surface-to-volume ratios.¹

A pond design that accentuates a curvaceous, sinuous, undulatory shoreline creates a ratio of high water to land-surface-area that is harmonic. A simple example is a shallow pond with the maximum ratio of water to land surface. Such a pond has lots of edge but may lack enough depth (interior) to moderate overall water temperatures and accommodate evaporative losses. If it does not dry up, this pond may allow for good bass conditions (warm water, low oxygen), but trout will have a hard time. A deep pond (*i.e.*, lots of interior volume and temperature-moderating cold water) with a serpentine edge begets the best of both worlds and allows for trout with our bass.

Fragmentation—For Whom the Edge Turns

Fragmentation of habitat is the predominant *modus operandi* of most developing cultures, as we turn natural resources into

¹ The description of coastlines as a series of Koch curves yields an understanding of the envelope of harmonic pulsation through time between the energetic interface of water and land. The resulting forms, however, are not descriptive of edge effects.

commodities. The loss of virgin forest habitat across the North American continent epitomizes the process. Roughly 1% of the original old-growth remains, after more than five centuries of a human-derived successional process that can be summarized as forest-field-desert. Our typical settlement patterns have effectively stripped the capacity of watersheds to slow, spread and infiltrate water. The permaculture movement is quite clear about the impact of deforestation on the functioning of soil, water, air and nutrient cycles worldwide. This ongoing removal of virgin habitat for agriculture/development is tantamount to a global Type 1 error.

Edge effects resulting from fragmentation include biogeographical impacts on:

- remnant size and shape,
- watershed location,
- run-off or run-on,
- initial diversity,
- length of time since isolation, and
- overall connectivity.

Edge effects must also be evaluated for their physical impacts on the remnant fragments, including energy fluxes in the forms of:

- wind,
- momentum,
- light,
- albedo,
- heat,
- fire,
- rain,
- nutrient flows,
- predation,
- parasitism,
- exotic species influx,
- erosion,
- desertification, and
- animal behavior.

The fragmentation of old-growth forests in the Pacific Northwest has raised serious questions about the survival of interior-dependent species such as marbled murrelets, spotted owls, red-backed voles and all salmon species. Yet populations of forest edge species such as Stellar's jay and common raven have been increasing and expanding in many watersheds. In eastern hardwood forests, numerous studies have established a link between forest fragmentation and increased rates of parasitism by the brown-headed cowbird on interior nesting songbirds. Studies concluded that a disproportionate number of songbird nests near the edges of forests were parasitized by cowbirds; nests placed deeper within habitat with interior forest characteristics fared better.

The effect that an edge has on any given species is unique to that species and to its relationships with other species that form the edge or ecotone. Furthermore, the extent of

the edge effect is relative to the species or form of energy that is of concern. For instance, how far do wind, frost or sunlight penetrate an edge? The ratio of edge habitat to interior habitat is determined by:

- the extent of a given physical edge effect, and
- the biogeographical size and shape of the fragment.

If the parasitization of songbirds by brown-headed cowbirds significantly occurs within 100 feet of the forest edge, then a square forest patch 200 feet on a side technically contains no interior songbird breeding habitat.

Fragmentation impacts wildlife through the quantitative and qualitative loss of habitat for food, cover, water and reproduction. By definition, fragmentation implies the loss of connectivity between habitats and the reduction of corridors for wildlife movement and migration. Ultimately, fragmentation results in the loss of functional interior habitat. What has happened to the "deep and dark woods" of lore? They are no longer so deep or so dark. A better understanding of the process and system response to fragmentation is critical in order for designers to be able to manage and recreate systems to support regionally appropriate integrated designs. Our existing hybrid landscape islands of natives and exotics are the legacy with which designers must work to craft unique solutions.

Tipping the Scale

Scale is also an important consideration for edges and their permacultural ramifications. Small fragments are typically impacted with external energies. In contrast, large contiguous habitats have enough interior capacity to facilitate their own feedback systems, such as soil generation, hydrological regenerative processes or viable diverse animal populations. Certainly, an individual tree is saturated with edge in the form of leaf surface area. When we move beyond observing structural differences at the scale of individual trees, however, the concept or pattern of ecotone—the edge between two macro vegetation communities—becomes apparent.

Fragmentation causes a crisis of scale, as we lose the opportunity to see forests for the islands of individual trees. We must incorporate scale linking, exquisitely articulated within the mathematical understanding of fractals, into our thinking process.

The organization of certain forms of energy into specific patterns can be observed in nature across every scale—from the orbital structure of an atom to the whirling of galaxies. Humans have created many devices to observe fractal diversity at different scales—electron microscopes, binoculars and tele-

scopes are just a few examples. The edge between a growing root tip and the soil is as dynamic and diverse an area as a forest/grassland edge or the Pacific coast intertidal zone.

All Edges Are Not Created Equal

There is an apparent contradiction between

- the conflation of edges as places with maximal biological productivity; and
- edges as places where fires, parasites, predators, desiccating wind and exotic weeds are exacerbating the loss of biodiversity.

The distinction is that some edges are natural, co-evolved ecotones that are implicated gradations bound by intact, contiguous, functioning interior habitats; while other edges delineate the random, fragmented remnants that currently litter the globe. The concept of ecotones as exceptional places of biodiversity had its genesis as students of the natural world observed intact, functioning ecosystems—not recently fragmented islands. An ecotone is only as productive as the contributing interior communities are ecologically sound.

On a continental scale, we do not need more edge in the landscape. Rather, we would do well to foster an increase of interconnected interior habitats. As permaculture designers, our understanding of the potential value of creating ecotone-filled designs should make sense in the regional context. We need to scale-link our ideas for restoration with the existing state of the natural world that we are hoping to restore.

Areas needing permaculture restoration are typically highly fragmented and filled with dysfunctional edges (not ecotones). The original process of fragmentation often converted the most productive lands first. These are, therefore, most in need of attention today.

Designs that both enhance interior structure and increase the overall area of edge elegantly fulfill the principle of stacking functions. If your site has a small patch of native vegetation, then design your polyculture planting strategy around the existing edge. By integrating your food forest as a regenerative buffer zone around your native remnant, the net result can be the expansion of the forest edge and a possible yield of interior habitat. Even three trees planted in a cluster can have a functionally different species/area support capacity and proto-interior structure than will one tree. A migrating neotropical Kirtland's warbler would be better supported by interconnected rural/suburban/urban polyculture forests than expansive disjunct plowed fields, green lawns and parking lots.

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Resonance: Aligning With and Amplifying the Chord

The dictionary defines resonance as “the effect produced when the natural vibration frequency of a body is greatly amplified by reinforcing vibrations at the same or nearly the same frequency from another body.” In *Living Energies*, Callum Coats defines resonance as “the free transfer of energy or sympathetic vibration between one system and another without loss.” Resonance holds systems together, and allows them to self-organize to greater orders of magnitude.

We experience resonance in our body. Tim experiences “knowing” the essence of place as a chord. He can “hear” resonance—whether there is alignment or discord between arrays. Vic experiences resonance as a feeling in her body where vibrations seems brighter and more vibrant. The deep brain perceives resonance; we must trust ourselves and open access to the deep brain to “hear” it. Recognition of resonance is probably a mechanism of intuition.

Dancing On the Edge

Where are human systems likely to find resonance? The practice of aikido offers insight into the human pattern of resonance with complex dynamic systems.

Aikido is about being present in the moment, immediately recognizing the initiation of an incoming threat or flow, blending with it, and redirecting its force. Blending creates a relationship to flow that matches its force, direction and extent—in other words, resonates with the force—while locating us just below the leverage point of the flow. The leverage point lies just off the line of the flow, not directly in its path; on the edge of the flow.

Aikidoists speak of this relationship as the dance with the enemy. It is an assertive, as opposed to aggressive, interaction. The dance expresses personal boundaries in the relationship to a partner who cannot comprehend them.

Conversely, the Aikidoist recognizes and respects the limits a partner brings to a relationship, and when avoidance or flight is the prudent course of action.

When we locate ourselves in the landscape, we’re dealing with an extremely dynamic and powerful entity. We want to locate our ki-point (the attractor in our system) in close enough proximity to the attractor in the landscape to benefit from the abundance of flow found there, but we need to be aligned with the attractor in such a way that we are not overwhelmed by flow. We do not want the magnitude of flow to destroy our system. Configuring this relationship means

finding the “fit” between our system and the larger landscape by perceiving resonance. Infilling the design is a matter of finding the “fit” in nested relationships.

If It Fits, It Will Build Itself

Once we find resonance—what permaculture literature calls “right relationship”—we can sit back and watch the natural self-organizing properties of systems do the work. But the dance of relationship doesn’t end. It’s a way of being in the world that deepens, builds, and continually transforms us and our partner in the dance.

For further exploration...

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Feeling Edgy?

In his video *In Grave Danger of Falling Food*, Bill Mollison states that “permaculture always did lie between the disciplines.” He is invoking the idea that the work for permaculturists is in the edges between the interior domains of specialized disciplines. We all bring to our work as permaculturists our varied experience, and we attempt to weave them together toward the creation of multifaceted designs. Being an unrepentant generalist is a desirable characteristic for permaculture designers. Permaculture designers are perhaps at best specialized edgy-generalists, serving as linking ecologists grounded by their ‘interior’ experiences and skills.

The resilience of the permaculture design system lies in the dance between the dynamic fecundity of the edge and the experiential maturity of what competent designers bring with them from their interior history. The more specifically experienced the designer is, the more solid is the foundation of inte-

rior capacity that the designer can bring to the challenge of weaving with others a new social ecotone that enhances and regenerates the contributing interior disciplines. Functional integration in a good design is based on sound knowledge of the interior and dynamic abilities to integrate, both conceptually and physically, newly derived system designs. This flow toward a new “edgeucation” from the straight and narrow path of specialization to the wide and wiggly path of interdisciplinary generalists is a path of ecological right livelihood.

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