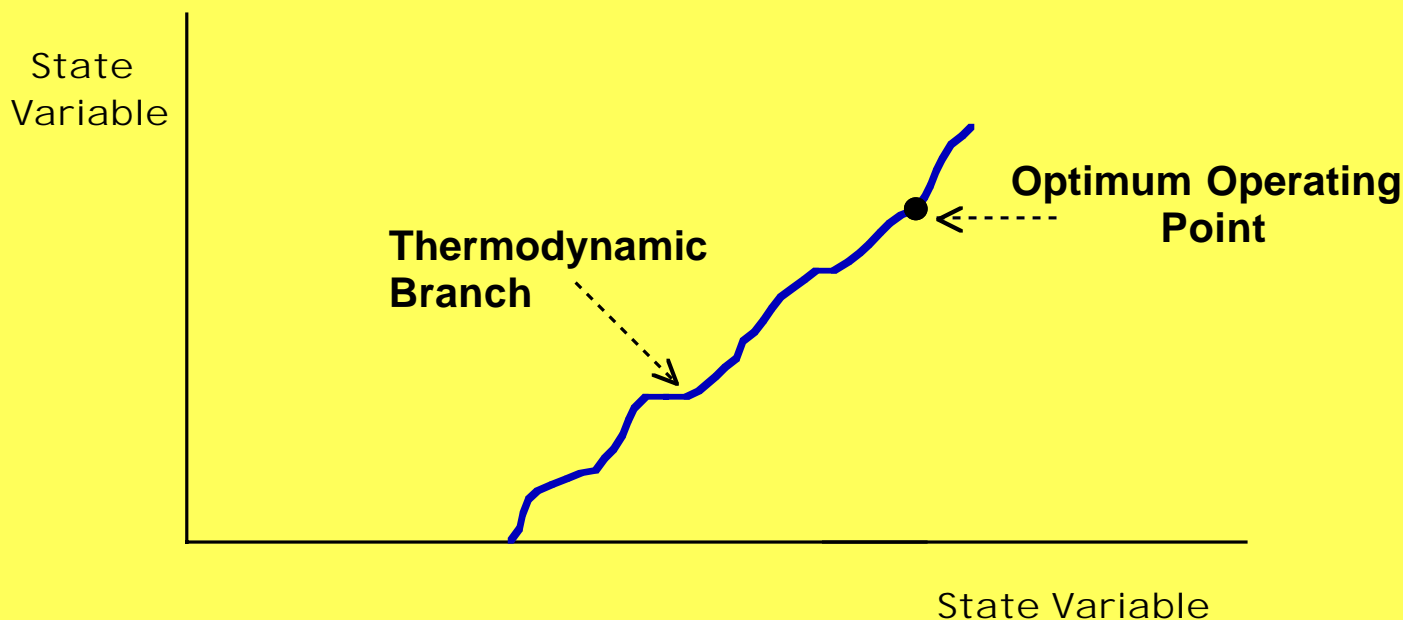


About ecological integrity

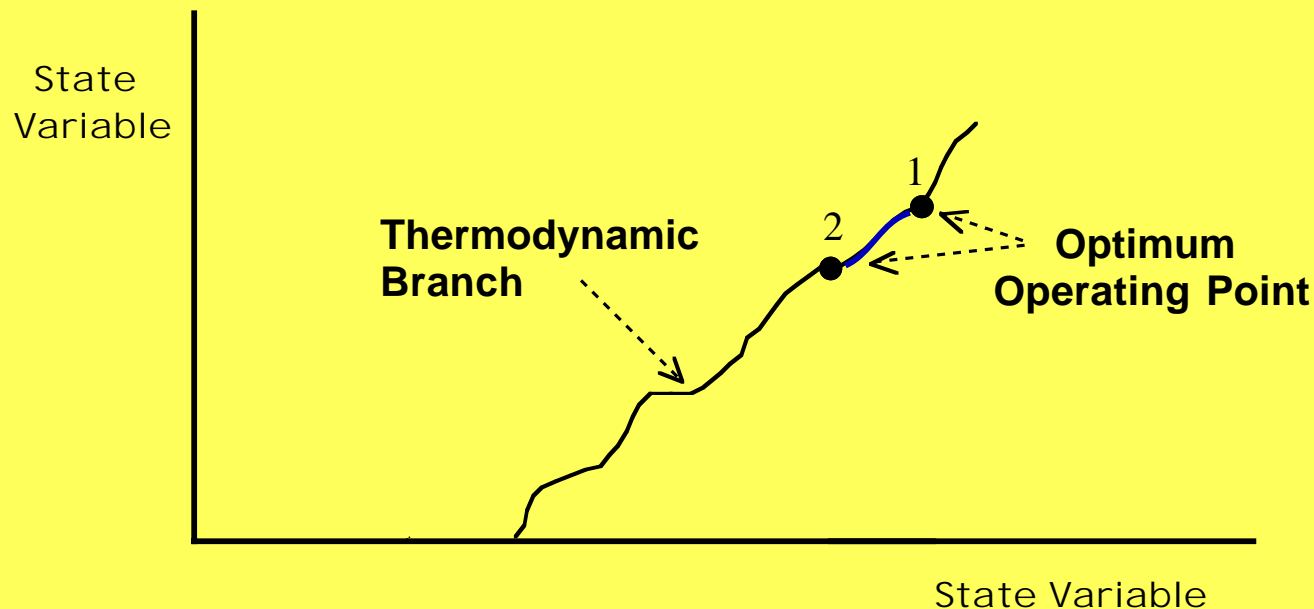
James J. Kay
with
Henry Regier

Development is characterized by phases of rapid organization to a steady-state level followed by a period during which the system maintains itself at the new steady state. The organization of the system is not a smooth process but rather proceeds in spurts. These spurts are a sudden acceleration in the change in the state of the system. The overall direction of development is one which satisfies the necessities of increasing energy degradation while enhancing survivability. An ecosystem develops along a Thermodynamic Branch (a path in state space) until it reaches an Optimum Operating Point. This is a point in state space where the self-organizing forces are balanced by the disorganizing forces of external environmental change. (This is a simplification of the more complex process described by Holling's figure eight.)



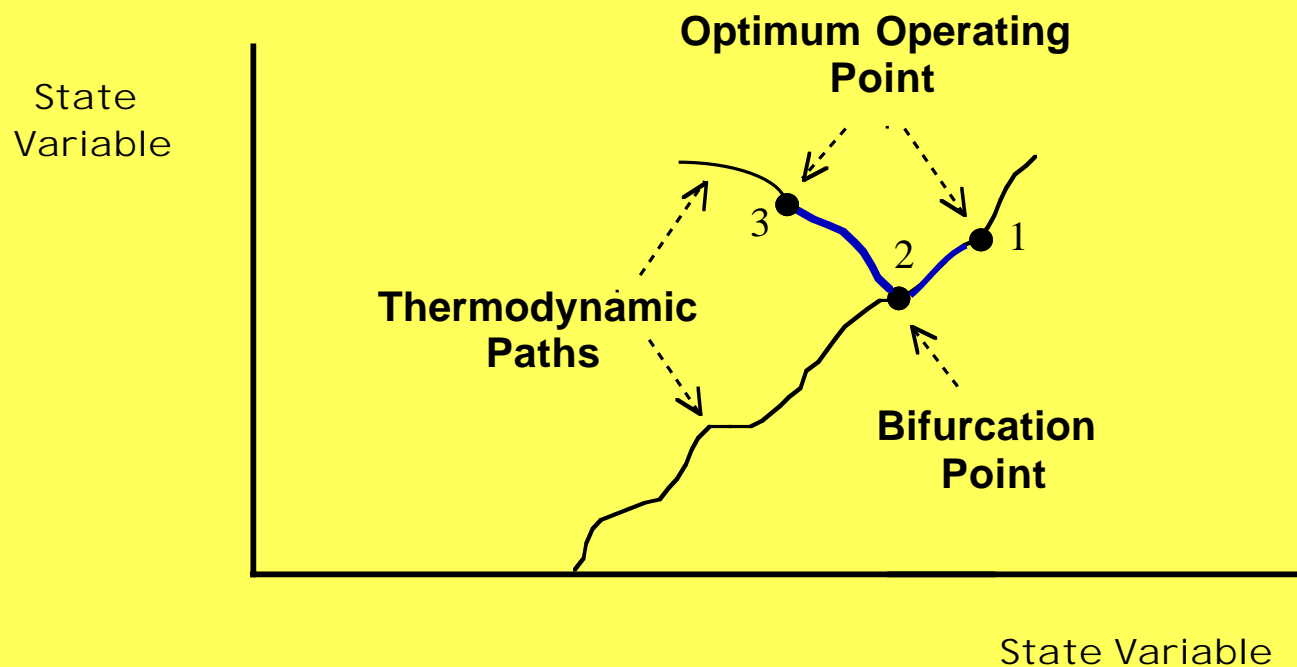
Simple stress response

The environmental change causes the ecosystem to move from its original optimum operating point (1) to a new optimum operating point (2). An example of this would be a stress which causes an ecosystem to return to an earlier successional stage. The practice of spraying the end product of the secondary treatment of municipal waste water on terrestrial ecosystems is such a stress. Pine forests subjected to such spraying are shifted back to an old field community (i.e. the developmental stage prior to a forest)



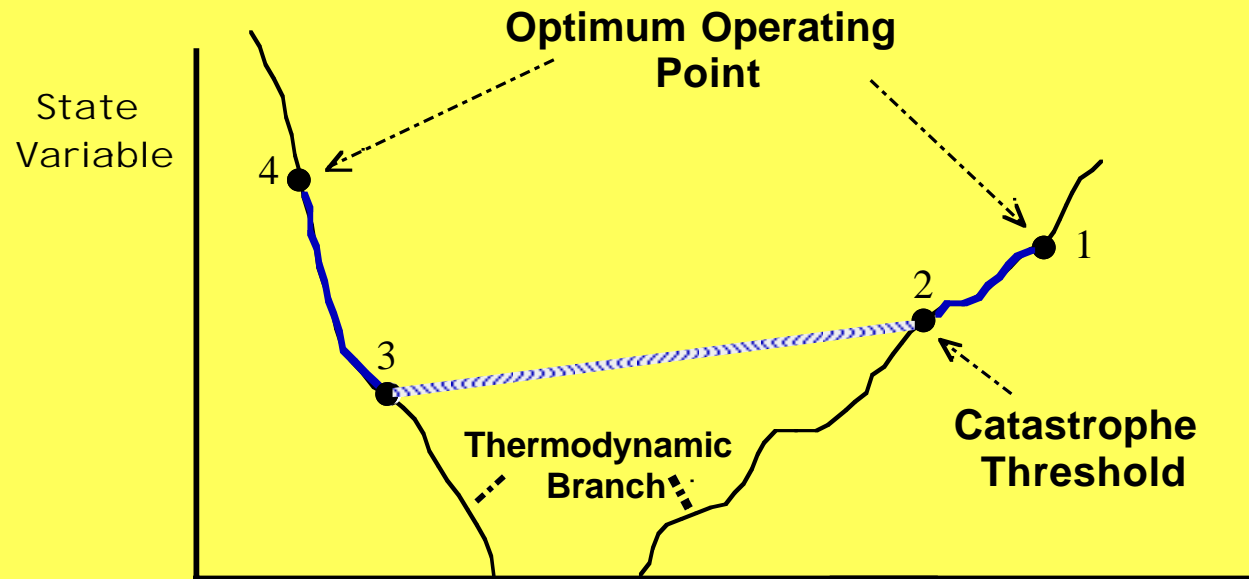
Reorganization

In response to changing environmental conditions the system moves away from the original optimum operating point (1) through a bifurcation point (2) and onto a new path and then to a new optimum operating point (3). An example of this case is the switch from a white spruce community to a black spruce community when the former is subjected to a sharp reduction in nutrient availability. In these forested taiga ecosystems, black spruce are better suited to low nutrient situations and once established tend to exclude white spruce by maintaining the low nutrient situation. The white spruce is not able to reassert itself once displaced.



A flip to a new attractor

The environmental change drives the ecosystem from its original optimum operating point (1) through a catastrophe threshold (2) to a new thermodynamic branch at (3) and eventually to a new optimum operating point (4). An example is the elimination of fish in lakes caused by acid rain. Another example of this is the switch between pelagic and benthic ecosystems in shallow lakes.



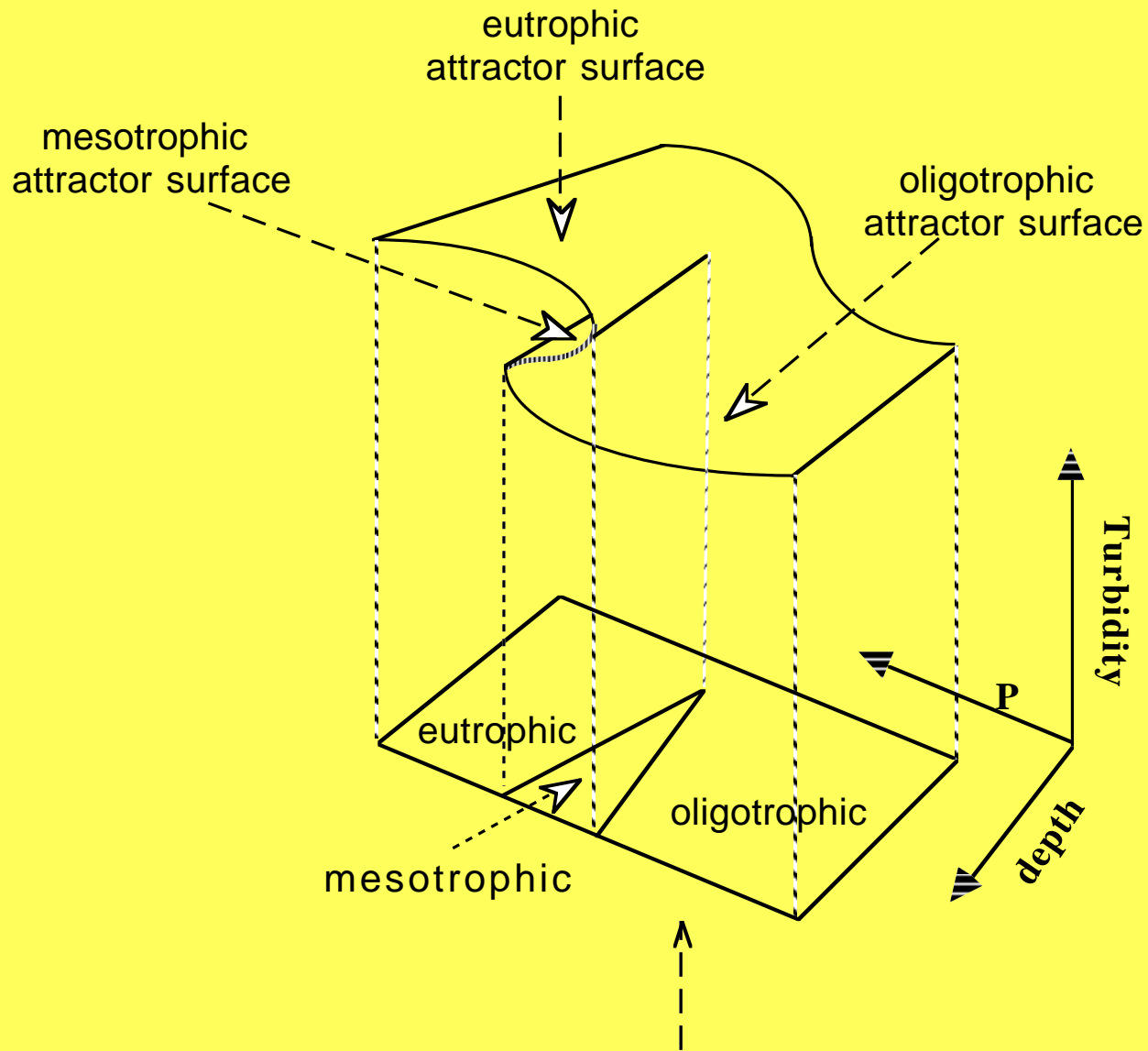
Qualitatively different organizational responses to environmental change.

the system continues to operate as before, even though its operations may be initially and temporarily unsettled

the system operates at a different level using the same structures it originally had (for example, a reduction or increase in species numbers)

new structures emerge in the system to replace or augment existing structures (for example, new species or paths in the food web).

a new dissipative system, made up of quite different structures, emerges.



Horizontal projection of equilibrium surface: *The Vollenweider chart*

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- **Which type of organizational change represents a loss of integrity?**
- **Does re-organization mean loss of integrity?**

An ANTHROPOCENTRIC component is required to discuss INTEGRITY

Three facets of Ecosystem Integrity

- Current Organization
- Ability to re-organize
- Ability to self-organize

Current Organization

Health, vigour, current well-being, flourish

About state of system (entity)

Status relative to its current attractor

Re-organization

stress-response, resiliency

About disturbing state of system (entity)

re-organization in the face of change;

ability to re-attain a state of

Ability to deal with external change that disturbs it from its current attractor point or changes it to the domain of another attractor.

Self-organization

Integrity

About patterns and process, function, development, and evolution

This pertains to the system's ability to develop, regenerate, and evolve in its normal environmental circumstances. This is about its capacity to:

- continue to develop, that is increase its organization relative to an attractor;
- regenerate, to deal with birth-growth-death-renewal cycle (i.e. the Holling four box model), that is to deal with the multiple nested dual attractor problem; and to
- continue to evolve, that is switch attractors spontaneously (emergent complexity).

An evaluation of ecological integrity must consider:

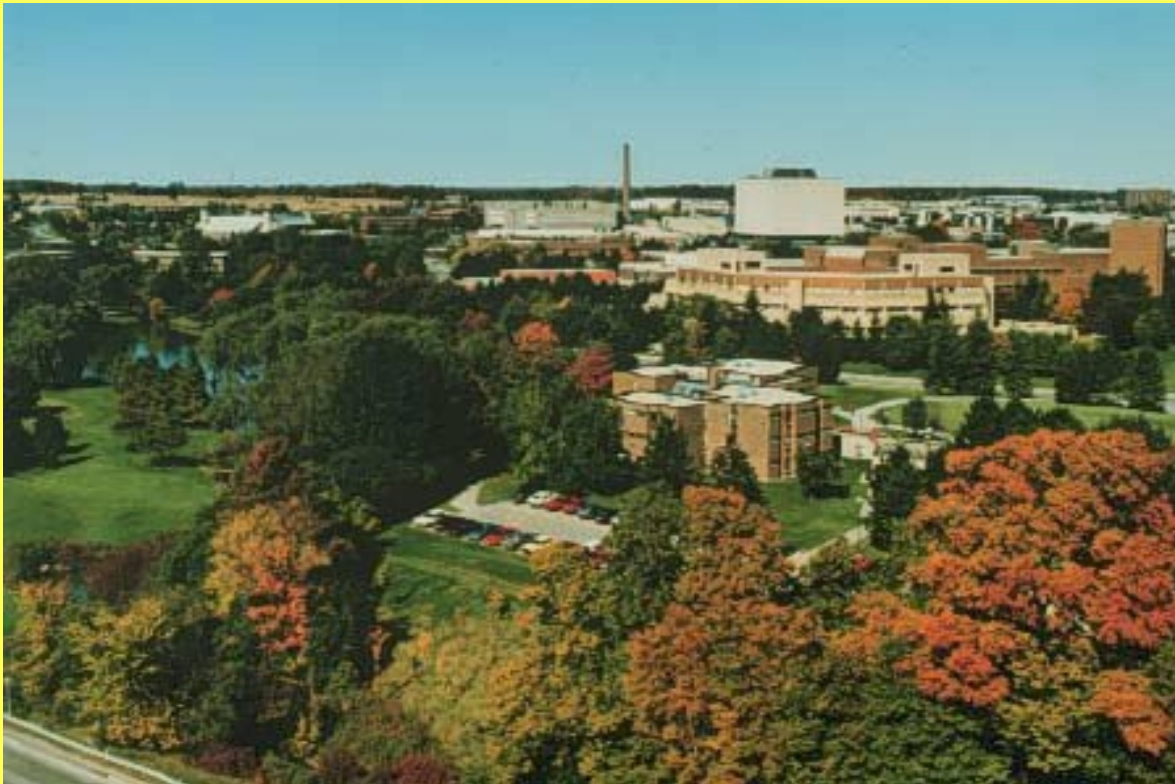
- the **current** organizational state of the system,
- the ability of the system to **reorganize** in the face of environmental change
- the system's **capacity** to continue to **self-organize** in its normal environment, that is to:
 - continue to **develop**, that is increase its organization relative to an attractor;
 - regenerate, to deal with **birth-growth-death-renewal cycle**, that is to deal with the multiple nested dual attractor problem; and to
 - continue to **evolve**, that is switch attractors spontaneously (emergent complexity).

Points to Ponder

- Integrity refers to the ability to maintain organization
- Measures of ecosystem organization can be used as indicators of integrity. (Exergy use, surface temperature, cycling, ascendancy, etc.)
- The organization of an ecosystem is a balance between the various influences shaping the system. The balance is constantly shifting. Thus discussions of ecosystem integrity are always about tradeoffs, as versus an ideal state.
- Integrity is a multidimensional notion that integrates all the different issues related to organization of ecosystems.

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