

The Roles of Science in the Global Ecological Crisis – As Solution Yes, But Not the Way You May Expect

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Introduction

Most have likely heard calls for science as needed to solve the multi-faceted suite of environmental problems we now face, what I call the global ecological crisis. While this role of science – to solve the crisis – is well-known, well-studied, heavily funded, and supported by many and diverse social groups, this essay is about a second role for science that I see as nearly completely ignored. The second one is the role of science – a specific type of science, and the dominant type now and for the past 400 years described below – as the root cause of the global ecological crisis.

I co-wrote a book with Brian Fath in 2018, “Foundations for Sustainability” (end note 1), in which we described this role of science as the root cause of the systemic global ecological crisis in great detail. Here I will briefly summarize the major ideas from that book, describe new sections that we are developing for the 2nd edition, and explain recommendations for what to do to solve the global ecological crisis. Despite much excellent work in many areas, I do not see enough awareness of the role of science as cause of the ecological crisis. I present the case here that this approach is fully necessary if we are to succeed.

In the book and this essay, I am speaking to scientists and others who think like a scientist, value science, look to science to help solve problems and serve human needs. I also mainly address those in the US and other industrial cultures, where I see the science-based problem to originate. However, since industrial culture is so completely infused with science, this approach could be familiar and of interest to many people. Science influences most if not all life on Earth, either directly or indirectly.

Full Disclosure and Important Notice

Before the synopsis of the book’s main ideas and reasons why the role of science is an important issue, I want to state a very important and emphatic explanation of the context and motivation behind this critique of science.

When I say that “science” is the root cause of the global ecological crisis, the primary explanation for our existential crisis of life support on Earth, I will be talking about *a specific kind of science*. I refer to the conventional science of roughly the past 400 years, the dominant mainstream science approach. For the love of acronyms, I call this ROAM science – reductionist, objectivist, analytical, mechanistic science.

We (in the book) and I (personally and professionally) value science in general, the scientific method, and the great archives of scientific knowledge. Science is essential, profoundly important and has the clear potential to be used 99.9% for good. This essay and our book are not in any way anti-science. Just the opposite – while the

beginning of the story portrays science as the root cause of the ecological crisis, the rest of the story depicts how science can and must be integral to the solution.

But all science is not created equal, and as Thomas Kuhn (end note 2) showed clearly, science is a social process like everything else that humans do. It also naturally evolves and undergoes revolutions and paradigm shifts. Progress cannot occur without self-critique, challenging assumptions, questioning results and methods, and proposing better alternatives. Our book and this essay describe a necessary paradigm shift in science that can serve to solve the global ecological crisis.

Credit to the Pathbreakers

While I continue to push hard for a paradigm shift, the necessity and description of the new paradigm has been provided by thought leaders before. Robert Ulanowicz and Robert Rosen, among others, gave us the conceptual foundations that we borrow from and build on. Robert Ulanowicz, to whom I refer as Bob, my PhD advisor, mentor, colleague and friend, has worked for nearly 50 years to understand ecosystems and ecological networks. His contributions have transformed ecological science and science itself. From him I have learned that ecology is not a derivative science, not merely an application of chemistry and physics to larger assemblages. Ecology is a fundamental science in its own right. Thus, the paradigm shift we propose results in a new science in which ecological science is relocated to a central and fundamental role. Bob also has conceived, written and taught an “ecological metaphysic” in which ecological principles help us understand all reality. And he has analyzed data and drawn graphs to show that all ecosystem networks – the relational webs in which all forms of life live and operate – naturally balance order (efficiency) and resilience (redundancy). He depicts this dialectical dynamic tension as an elegant and meaningful realization of what he refers to as “our two-tendency universe”. All of these key concepts are infused into the 2018 book and inform this essay. A key reference for Bob’s work is his 2009 book, “A Third Window: Natural Life beyond Newton” (end note 3).

Robert Rosen likewise created paradigm shifting and fundamental concepts when he addressed ultimate questions like What is Life? We borrow and build on Rosen’s idea that the machine metaphor in science must be challenged and changed, and that the key to understanding life is to recognize how life is different than a machine. Rosen’s “modeling relation” serves as a useful generic model of science. His discovery of the need for impredicative logic to understand life is essential to the new paradigm we propose. A key reference for Rosen’s work is his 2000 book, “Essays on Life Itself” (end note 4).

In the same future I imagine in which we solve the global ecological crisis, these two will enter the pantheon of the greatest scientists, thinkers and science contributors to society, right beside Charles Darwin, Albert Einstein, Rachel Carson, Donella Meadows, and their peers. I am forever grateful for their contributions, and see continued exploration and development of their ideas as one way to show respect for their leadership.

What We Wrote in 2018

Here comes a synopsis of the book, *Foundations for Sustainability: A Coherent Framework of Life-Environment Relations*.

We focused on the “global ecological crisis”, the situation we face now with 10 or more environmental crises all happening at once. It’s what we referred to in the book as a “mess”, a term from Russell Ackoff which he coined to describe “a system of problems”. It is a long list, very important to understand, likely familiar, and some will be described specifically below. Perhaps the “sub-crisis” items on the list, and their essential interdependence,

will take on new meaning after this essay. Given our situation and the stakes, I'm assuming a new perspective could be a good thing.

We are facing what other folks have called a "metacrisis", "polycrisis", "wicked problem", or Ackoff's "mess". Though crude, in the common vernacular, "clusterfu*k" also fits. Faced with this kind of challenge, many will pick a single sub-crisis. For example, many focus on the climate crisis and then focus on understanding the causes and solutions for that in isolation from the whole situation. As ecologists and systems scientists, we took a different approach. We asked – *what is it that all of these sub-crises share in common?* Can we learn anything from how these symptoms are connected in a system of problems? Is there a single root cause underneath the whole set of surface symptoms? (Note: in addition to climate disruption, we face mass species extinction, nitrogen cycle disruption, unsustainable water use, toxins and pollution, energy crisis, food crisis, and more.)

There are parallels with diagnosis. I dedicated my part of the book to my father, Guy Fiscus, who was a physician and very skilled at diagnosing illness. Growing up, as I watched him work, it sank in for me that often the cause of illness is several layers below the observable surface symptoms. And, at times, the surface symptoms can be distracting, red herrings, and only indirectly useful for identifying the cause on the way to crafting a real cure for healing.

The pursuit of these questions of environmental sustainability has been a passion for me, an almost childlike determination to keep asking Why? over and over again. In this quick version of the book, I leave out most of the hard science and citations of many corroborating sources. These aspects are essential to the diagnosis and prescription we proposed, and they are all there in the book. This is more of a "science-lite", narrative version; it includes some of what led to being able to write the book, a sort of timeline for the quest I was on. The question at the start was a scientific question – a search for a causal explanation of a real problem.

What is causing the global ecological crisis? Well, it seems to be associated with industrial culture. We know that Indigenous cultures are not damaging ecosystems in systemic and planetary ways, so we focused on industrial culture. [Note – the leadership role, wisdom and practical success, remarkable track record, beauty and strength of Indigenous cultures in having already solved this crisis is one area to be greatly expanded in our book's 2nd edition.]

Well, why? What causes or drives industrial culture? A major factor is industrial technology – the many clever machines that burn fossil fuels; transport humans and materials all over; define modern homes, offices, factories and buildings; create and distribute toxins; destroy habitat causing mass extinctions; transformed farming into industrial agriculture. Industrial technology seems very closely connected to the cause of industrial culture and its impacts.

But why? What causes or drives industrial technology? Well, it seems clear that science is what makes industrial technology possible, so effective at getting things done, and so powerful. OK, so it seems science is directly involved.

But why? What is it about science specifically that influences technology, that could start this long chain of relationships, and that could end up damaging the planetary environment in 10 or more different ways?

The answer to this question is the focus of our book.

I highly recommend reading the book. I know I said we are revising it, but all the parts that cover from the origin of Life up to 2018 are really solid for the topics we addressed.

It is important to note that one could, and many others do, focus on other root causes of our predicament. Capitalism, economics, fear and insecurity, ego, democracy, religions and worldviews, and others. These are great to explore, work on, and heal, and we truly need an “all of the above” approach to achieve systemic change. Folks in other realms are leading in excellent ways, such as regenerative agriculture, renewable energy, raising awareness and many more. But all this great effort appears to be not enough. We focused on science in the book, and I continue this focus, because few if any others have been, and because I see no successful future unless science changes fundamentally. Also, I have not seen a “turning of the corner” or great breakthroughs. We are still on a very bad trajectory, so we need to try something different.

The real kicker reason for this focus on science is that many folks and organizations continue to use conventional ROAM science and believe it, promote it and teach it as an effective approach toward solutions. Looking at the brutally honest reality and evidence – continued use of ROAM science is making things worse. Brian has said that you can look at almost any advance in technology, anything that was lauded at one time as a great solution to some problem, and then document that each “solution” turned into an unintended problem itself. Often the “solutions” developed with ROAM science are worse than the problems they supposedly solved. This helps explain why we continue the bad global trajectory even though we have thrown all the science we possibly can at the problem. Again, all science is not created equal. Brian also points out that key factors like scale and growth play roles here, and the interactions of industrial technology and growth, as in the Jevons paradox. While these are certainly key factors, the central role of the underlying science remains a pivotal driver.

Another important note and reminder of the value of science in general – I will walk through this search for the root cause once, and identify what we see as the root cause. But the “thing”, ROAM science, we identify as the root cause in phase 1 turns out to be a solution for something else in phase 2.

Our 2018 book, and my ongoing focus on the science paradigm, were inspired by work of Donella Meadows, who is famous in part as the lead author of the book, *Limits to Growth*. She also wrote about the greatest sources of leverage for change in complex socio-environmental systems. She identified the paradigm of culture, and the power to transcend cultural paradigms, as the #2 and #1 most powerful ways, respectively, to achieve systemic change. We combined her insight on how to get great leverage with other ideas and came to the view that the paradigm of science needs to change for us to solve the global ecological crisis.

Brian and I both worked in science for many years, and we felt it important to address the role of our own field in the global ecological crisis. It has been an approach to “get our own house in order”, or to lead by example. This seems a priority, a necessity, before working in science and focusing scrutiny, criticism and calls for change on other fields like agriculture, energy, government, etc.

When we asked ourselves what is the role of science in the global ecological crisis, we had to admit that science has a mixed record. On one hand, science has produced many advances in knowledge and capability that have improved people’s lives and, in many cases, also improved the environment and saved other species. However, we did a hyper-honest self-examination, which was ultimately driven by a sense of the necessity of success in solving the systemic crisis. We came to see that the overall bottom line of the global ecological crisis – the distilled essential fact that industrial human actions are degrading the environment – has the fingerprints of conventional ROAM science all over it.

Here are three foundational concepts and values that we presented as necessary for a new science paradigm to provide the leverage to solve the global ecological crisis. Each of these is just the tip of a large iceberg, and all the details are in the book. This walk-through has a mix of both the problem part and the alternative we see as

the solution part. These core concepts emerged at the intersection of the needs a) to develop scientific concepts that fit with reality (good science) and b) to develop scientific concepts that can help solve the systemic global ecological crisis (science to use for good). We call the proposed alternative paradigm Holistic Organic Life science.

Three Foundational Concepts of Holistic Organic Life Science

1. Conventional ROAM science asserts the importance of being objective and value-neutral. We suggested that unless science is grounded with a clear value basis, then it can be mis-used, as in being used in ways that damage the environment and life. We cited Aldo Leopold, Albert Schweitzer and others who wrote that the most important value, the foundation of ethics, is Life. We adopted Life as the primary value as linked with our specific holistic definition of Life. From there, we proposed “Science in service to Life” as a founding principle of a new science paradigm. When we wrote Life with a capital L, we spoke of Life itself, Life as a unified whole, Life in its organismal, ecosystemic and biospheric scales all integrated. We described how the Life value basis causes no loss or harm for science, as it does not privilege anyone or lead to any negative kind of bias. We all are involved equally with Life, and so the Life value orientation serves everyone equally, without favoring any special interest group. This value focus provides no incentive for, or threat of, skewing data, fudging results, or focusing on anything other than evidence and real relationships. Once science is grounded with a clear value basis of service to Life, then it cannot be mis-used in ways that damage Life and the environment. The next point fuses these last two into a single entity.

2. Conventional ROAM science splits Life apart from environment and treats the two as categorically different. We wrote of the necessity to view and treat Life-environment as a unified whole. Terms often used in ecology and environmental science are “biotic” and “abiotic”, and this dichotomy is assumed as true, with two mutually exclusive categories. Brian’s term, *conbiotic*, to us better indicates that Life and environment are always inseparable and always entangled (at least on Earth). There are many profound implications of this holistic concept. For example, once we treat Life-environment as a unified system we realize that the Life-environment relation is win-win. Life “knows how to”, always does, operate in ways that improve the environment over time. This is why soils naturally grow in depth and fertility, why Earth has an oxygen atmosphere, etc. Another major implication is that if we always keep Life-environment unified, then it is not possible for the environment to be treated as having lesser value, and thus it cannot be ignored, discounted or sacrificed relative to any other pursuits or values. There may be equal values, but none can be greater. We started by adopting Life as the value basis for culture and for science. Once Life-environment becomes a unified whole, then environment comes along by necessity as integral to the value basis.

3. The third foundational idea in ROAM science that we showed requires a new paradigm is the root metaphor, the main idea in conventional science, of the mechanism. Going back to Descartes and Newton, the mechanism has become the fundamental scientific unit of reality, the assumed organizational pattern of all systems, the accepted concept for the way things work, the essence of all physical things, in Nature. It may have started as a hypothetical model or metaphor, a useful juxtaposition to help with science and communication. Like, “Let’s assume for discussion purposes that an organism is like a machine...” However innocently it may have started, you can hear and see how this root idea has become *reified* – where an abstraction is treated as real – everywhere in mainstream science. The goal or gold standard is to “understand the mechanism” of any given system or phenomenon, or to develop a “mechanistic model”. The use of mechanism often means “cause” or “causal explanation” – and it seems to mean the actual, real-world, ontological cause itself, not just a manner of speaking or an epistemological pointer to a real cause. In our book, we described how treating Life as

mechanism leads to many problems. Assuming that Life and mechanism are similar in both being entropy-producing and environment-degrading can justify the assumption that human-caused environmental degradation is normal and unavoidable. We show how crucial it is to contrast and distinguish the machine-environment relation which is win-lose, with the Life-environment relation, which is win-win. Mechanisms and machines are entropy-producing and can never be sustainable (as they currently exist, and not with respect to simple machines); Life is self-organizing, self-repairing, entropy minimizing, and sustaining.

Those are perhaps the top three major ideas in our book, but there are many more, perhaps 30 in all, that are closely linked and all essential to the critique of ROAM science and the proposal for Holistic Organic Life Science. I will take one more walk-through below, but first here is one way to grasp the profound implications of this approach.

To say that the idea of mechanism has become reified is to become aware that it operates at a sub-conscious or pre-analytical level. While the idea of mechanism as the basic working unit of the universe may have started in science, it has permeated nearly all aspects of industrial culture via that entangled complex of science-technology-culture. Over 400 years, it has become an idea most of us think with rather than an idea of which we are consciously aware. The ultimate, shockingly tangible and brutally obvious result of the total permeation of this abstract scientific idea through all of our technology, and all of industrial culture, is this:

We have turned the world into the machine that conventional science has modeled it to be

The world is literally running out of gas, breaking down, and wearing out, just like a machine. That this behavior is the opposite of Life, ecosystems and biosphere, which naturally improve themselves and the environment as they operate, proves that environmental degradation is by no means universal, normal, natural or unavoidable.

Think about all the comparative cases. If you let your car run out of oil and ruin the engine, it does not heal itself. If you over-farm a patch of land to death and turn topsoil into sand, it will heal itself (even if it takes 200 years). We in industrial culture are extracting and burning fossil fuels; the biosphere created fossil fuels. We are causing the 6th mass extinction; Life has evolved and self-sustained while surviving five prior mass extinctions.

This is a clear case that we have turned the world into something that is not its true nature, something that we humans invented in our minds. This proves the power of science, in concert with technology and culture, to change the world. And it aids understanding of science as pivotal in causing the crisis, and leads to awareness of how and why science can be the solution. It is the most extreme and extremely well-evidenced case of “mind over matter” I have ever encountered.

That’s a lot to unpack, and that’s why that 250-page book has value. I tried to hang the book synopsis on the scaffolding of these three big ideas above, but the larger list of about 30 concepts that we see as either unique or uniquely employed are all essential to understand the problem paradigm and the solution paradigm fully. We talked about each paradigm as a “system of ideas”, and they are both sprawling and tangled like messy hyper-linked holograms. See Figures 1 and 2 for a graphical view of many more of the main the ideas.

Next comes one more way to express the paradigm we proposed, the Holistic Organic Life science paradigm (HOL science), like walking around a hologram to see it from another angle.

At the start of one more walk-through walk-around, consider the context of the kind of mindset shift we are going for here. When people say things like “follow the science”, “trust the science”, “we need science-based solutions”, etc., keep in mind that this could lead to radically different kinds of science and related science-based solutions if you are right on the cusp of, and living through the real-time process of, a scientific paradigm shift. Also, as said above, this idea of a radical mindset overhaul helps understand the seeming paradox that science can be both the root cause of, and the root solution of, the global ecological crisis.

Back to the book...

As I said, we wanted to frame the problem, the global ecological crisis threatening the planetary Home we love and are devoted to protect, in a way to solve the whole problem – not just one of the subset symptoms of the problem (see Figure 3). Thus, we were not interested in applying temporary fixes or patches, kicking the can down the road, or buying time while trying to delay the inevitable.

We had hunches that the typical kind of science approach, now also the industrial culture’s common sense “break the problem into smaller pieces” approach, would not work to solve the mess. Russell Ackoff said it well: “The solution to a mess can seldom be obtained by independently solving each of the problems of which it is composed.” And Eisenhower gave us another hunch; he is attributed with the idea “To solve a difficult problem – enlarge it”. While I am presenting the outlines here, the book credits and quotes dozens of others who either said the same basic things or contributed crucial parts to this new system of ideas.

One more analogy. My work is a shift from a focus on “low hanging fruit” to a search to understand the “deep tangled root” of the crisis. Low hanging fruit is the quick and easy change, like changing light bulbs. It may feel good briefly, but it does not have any chance to solve the real problem. The deep tangled root is the really hard change, like understanding and then envisioning a reorganizing of industrial culture from its scientific foundations. This strategy could take a similar 400 years to bear a new kind of fruit – millions and billions of human actions that naturally enhance, preserve, sustain and improve the Life-environment system rather than degrading it like an over-used machine. If we work fast, in clarity and cooperation, it need not take 400 years to succeed.

Here’s the same story from the book in chronological order that flows from root cause at the center and the start and then going forward, upward, and outward to many surface symptoms of crisis. It’s a very brief history of the life span of ROAM science – reductionist, objectivist, analytical, mechanistic science – and its legacy of real-world impact. It is our hypothetical story of the origin of the global ecological crisis.

The fundamental ideas and methods of the paradigm of conventional science start up around 1600 with Descartes and Newton. Their approach and the work of others leads to great advances in understanding how the world works. This is when the machine or mechanism becomes the root metaphor that over time is applied to all subjects of scientific study, and by extension to all phenomena.

As biological sciences develop, the same root metaphor of mechanism is applied fully. The myriad forms and subsets of Life are thus modeled in mechanistic ways. Using the analytical and reductionist tenets of ROAM science, Life is considered a property of cells and organisms, and these discretized, artificially cut off Life units are equated with mechanisms. As ecological and environmental sciences develop, mechanistic, analytical and reductionist principles are seen again in the split of Life from environment.

Along the way, and as objectivity has been another fundamental principle, science is taught and promoted as being “value neutral”. As a consequence of this passive, ungrounded stance, it is often pressed into use for war, oppression, exploitation of people and the environment, and many other purposes harmful to people and Life itself.

Science grows in power and impact and shapes the value basis and all aspects of industrial culture. The physical and scientific nature of machines and mechanisms as inherently entropy-producing is projected on to all other things. Entropy-production is assumed to be the true nature of all systems including Life.

This leads to the view of environmental degradation as normal and unavoidable, for humans and all Life, as is normal and unavoidable for entropic machines. A related development is that the value of the environment is seen as less than the value of Life, especially human life.

As all these scientific and technological ideas, values, root metaphors and the overall worldview permeate industrial culture, they influence the choices and actions of people. Choices and actions based on beliefs such as “life is a mechanism” and “environmental degradation is normal and unavoidable” are repeated millions and billions of times.

The compound effect of these billions of actions leads us to the present day – a world in which we see multiple diverse symptoms of environmental degradation – the metacrisis, the mess. Some people act surprised at what we have done, but it seems a straightforward result of the fundamental ideas for how the world works that have been taught to nearly every school child in industrial or pre-industrial cultures for 400 years.

These steps can be considered as the concentric rings in Figure 3, with labels A through E loosely corresponding to the science paradigm, the science enterprise, technology, culture, and the visible symptoms of crisis.

To imagine an alternative history that might have unfolded differently since Descartes, we wrote this in the book related to his famous statement, “I think therefore I am”:

“Imagine how his insights, and the course of history, might have changed if ecology and the knowledge of ecosystems and the human place of interdependency in them were already well known at the time of Descartes’ revolutionary work...then he might have concluded:

I think, therefore I exist. That is, I think now, therefore I exist now. But I think only as long as I have a steady input of oxygen, water, and food to sustain my thinking via my life. And, after I am done thinking with aid of these vital materials, they are transformed and expelled not so much as waste but as food for the plants and other living beings that in turn create and supply my material needs. I think only as long as I exist in concert with the existence of these other life forms, and vice versa.

I think, therefore, I am. . .we are. . .an ecosystem.”

I am going to wrap up the detailed synopsis of our 2018 book. There is another major thread which, while very important to the whole story, would require many more pages to discuss. It’s almost impossible to slice it off and not talk about it, as it is an essential part of the organic whole of this approach. Here is an attempt to describe it briefly; full explanation will have to wait until you read the first edition, or the revised 2nd edition, or I can write another essay focused on this other half synopsis.

All of the above is in essence only 1/3 of the story of the book. The critique of ROAM science, and the proposal that HOL science is necessary to solve the global ecological crisis, is our story for what we called the Sustainer culture in the book. We described two hypothetical cultural types to help explain the conflict and confusion of our times. Here is what we wrote about our hypothetical typology of Sustainers and Transcenders:

“This typology starts by assuming that everyone is aware of the environmental limits, constraints, and challenges now increasingly apparent, at least at some general level. However, the proposal is to see two different responses to this awareness. These two groups we label as ‘Sustainers’ and ‘Transcenders’, in order to make the typology value-neutral similar to Myers-Briggs personality types. We are not trying to say that either is ‘good’ or ‘bad’, or that one is better than the other in an absolute sense.

In this typology, the ‘Transcenders’ are aware of environmental limitations (again, even if just at some general level such as ‘human impacts are damaging the environment’, or ‘we are starting to see real shortages of key natural resources’), but when confronted with a perceived limitation they seek to break through it, innovate out of it, or change the world to *transcend* that external barrier or limitation. The ‘Sustainers’ adopt the opposite approach, and they accept the perceived environmental limit and then seek to change themselves to fit within, and *sustain* a lifestyle and culture within, that perceived real world constraint.”

We go on to say that the way of the Transcenders is aligned with a natural, fundamental and essential aspect of Life including human life related to dispersal, migration, and exploration. We also suggest that ROAM science is appropriate for, and fully required for, the ultimate adventure of Transcender culture – the project to extend Life beyond Earth. This working model for two cultural types gives the basis for describing a possible win-win relationship between two seemingly opposite worldviews, sciences and cultures. It provides the basis for seeing the best of ROAM science as valuable and worth preserving while also showing the Holistic Organic Life science must be employed for Sustainer culture to succeed. The three components then are 1) the Sustainer way, 2) the Transcender way, and 3) finding a way for Sustainers and Transcenders to coexist in mutually beneficial relationship.

The two-culture dichotomy shows up in the sections that follow. Some of the new ideas and also the recommendations for what to do will refer to the fundamental distinctions between Transcender culture as imagined as successful in the future with its modified ROAM science, and Sustainer culture as imagined as successful in the future with its HOL science. And, in true complementarity, much like plants and animals, the two need each other for Life to succeed. I realize this opens many large cans of worms, but we will have to ignore their wiggling calls for attention for now.

New Ideas Since 2018

We thought we had written a pretty good book, but given all that has changed since 2018, it is not surprising that we have accumulated a large list of changes to make for the second edition. Some of the changes were indeed sparked or amplified by recent events, and others, honestly, were omitted due to the complexity and time required to address them coherently. I will only describe in detail one recent thread in the works for the second edition, and then briefly mention another set of topics that will also be added.

Along the path of asking Why? about the global ecological crisis, I described a search that led from culture, to technology and finally to the paradigm of science as the root cause. From there, and throughout the synopsis of

the book, it becomes apparent just how deeply science, technology and culture are entangled in industrial culture.

Awareness of this entanglement is helpful, because it may allow us to understand part of our confusion and inability to make real progress. One impediment may be due to the fact that the symptoms of the crisis appear in culture or the environment, but the sources of the crisis are indirect in relation to the symptoms and are obscured by several layers in between.

When Kuhn described the “structure of scientific revolutions”, the recurring process through history by which paradigm shifts happened in science, he described cases in which a “crisis” would arise in science. Such a crisis typically involved the inability of the prevailing scientific theories, models, methods and equations to explain certain phenomena. He described this with reference to the shift to the Copernican model of the solar system, how Einstein’s relativity become the prevailing view in physics, and many others.

It may be that the natural social process of scientific paradigm shifts Kuhn described has been altered in our current situation. Instead of the crisis appearing as a crisis for science, it has appeared as a crisis in culture. And, without explicitly considering science-culture as a unified if messy entanglement, it has not been straightforward to ask whether the global ecological crisis we face may be a crisis of science. Thus, when we in 2018, and others before and after us, suggested this, the proposed diagnosis does not gain attention.

Another part of the confusion and inability to make progress in the crisis may come from the shared assumptions in industrial culture that 1) science is key to the solution and 2) science is all one “thing”, and always a good thing.

In the next edition of our book, we will explore and expand on the ideas that the solution requires realizing that, in reverse order, 2) not all science is the same – there is good science and bad with respect to sustaining Life and solving the crisis, and 1) of two general kinds of science, only Holistic Organic Life science is good for solving the Sustainer third of the current crisis, and ROAM science is bad for solving the ecological crisis but excellent for solving all manner of challenges facing those of the Transcender way of Life-environment relation.

Finally, given that culture and science are tightly coupled, in close mutual relation, I want to acknowledge that one can start in either place – change science, or change culture – to push for the paradigm shift and crisis solution proposed. It is also possible that both must change in parallel and the two change strategies must be coordinated. Having coming up through science, I speak from the framing that science is primary, it drives culture, and science must change first. And I can understand that this is a choice based on my social context and cultural perspective, and I can respect that the reverse approach is also valid and needed.

More Major Topics for the 2nd Edition

I have two sets of topics that I plan to develop into new sections in the revised version of our book. The first are additional ecological science topics, fundamental principles of how Life works gleaned from over 25 years in ecology. Also in this first set are revisions to the examination of the historical process of paradigm shifts in science. The second set of necessary new topics generally address social justice and what we must learn from Indigenous cultures. Many of these topics, which are still related to Holistic Organic Life science, have become even more pressing for focused collective attention since 2018. Finally, I also am seeking comments, constructive criticism, and suggestions from anyone willing to share insights, help with revising the book, and ultimately help in solving the global ecological crisis. I will work to incorporate any comments I get into the 2nd edition (see my email address at the end).

The first of the ecological additions will be an in-depth description of ways in which dispersal, migration and exploration are fundamental, inherent, necessary and commonly observed aspects of Life. Comprehensive examination of Life's natural environment-transcending way is both good science (rigorously true based on evidence) and science for good (powerfully useful to help end conflict and find synergy between the hypothetical Sustainers and Transcenders).

A major section is needed to describe the natural necessity of dispersal and expansion and how this urge to push outward is inherent in all Life and has occurred repeatedly in human history and culture. This will include a detailed look at the observations and evidence and cite numerous works by many in diverse fields to understand the causes and contexts of non-human and human dispersal since the beginning of Life. From this perspective of the necessity and ubiquity of dispersal, current efforts by NASA and other space agencies can be seen in new light. As integrated with the Sustainer way, Transcender efforts to explore, travel and establish colonies in space will not appear as frivolous, unnecessary, wasteful or "running away" from problems on Earth.

Many plant species have evolved seeds with elegant forms that allow travel on the wind and water for dispersal to habitats at varying distances from parent plants. Seeds of some plants hitch a ride in the fur, or in the gut, of animals, and thus have co-evolved via a knowledge of living as well as physical transport options. Many birds, marine species, ungulates and other groups migrate long distances every year thus expanding their home range to two main areas plus the paths between. Benefits – such as improved feeding and breeding grounds, genetic diversity, climate adaptations, and more – reward such traveling behavior over evolutionary time. Some species arrive to new habitats in combinations that make colonization of inhospitable terrain like a new volcanic island possible. Lichen and their allies know how to terraform barren rock into the lush tropical Life of the Hawaiian Islands. And every such new barren volcanic island that appears will be naturally and seemingly effortlessly transformed in the same recurring ecological Life processes of colonization and succession.

This innate urge to move, spread and expand to new terrain is seen in humans as well. Speaking of Hawaii, the original human Polynesian inhabitants are thought to have come from the Marquesas Islands around AD 900 to 1200, a distance of over 2000 miles across open ocean (end note 5). The people who first arrived in North America about 15,000 years ago are thought to have migrated via land bridges that opened at the end of the last glacial period (end note 6). Summary of past and present evidence, and synthesis of why all Life forms disperse, may include discussions of the pros and cons of hedging bets about survival in a single locale, gene flow, reducing competition for space and resources, and dealing with climate change, as well as dispersal by chance, accidents, storms, and other unintended means. In the near and very far future, threats such as impactors from space and the eventual death of the sun ensure that the strategies of dispersal and exploration will continue to be actively debated and pursued, including consideration of realms beyond Earth.

The integration and elevation of the Transcender way of Life to equality with the Sustainer way is part and parcel with the strategy for solving the global ecological crisis. Both modes, even though seemingly opposite or contradictory, are necessary for a successful human future, just as they both have been necessary for Life's success over 4 billion years. This complementary approach is important because we need to envision, articulate, chart and begin positive ways forward that include diverse roles. This strategy is not just "going back" to prior ways that were more sustainable, although doing that is part of the solution. Adding a second and very different positive future for those naturally attracted to the Transcender way acknowledges that machines and the best aspects of ROAM science, while bad for sustaining on Earth, are excellent and needed for Transcending to new environments.

We have to continue ROAM science, the best aspects of it, including the use of machines for specialized tasks. This is not the typical Kuhnian paradigm shift that we proposed in the book. This is a proposal for, and a forecast

of a coming, *paradigm bifurcation*, or a switch to a *dynamic paradigm*. A modified ROAM paradigm has a place in the future, but it must find a new home and new culture to build a new place and a modified mission for itself.

Other topics under this ecological and science section will include additional coverage of “process ecology” and “an ecological metaphysic” of Bob Ulanowicz. Bob’s current project on the dialogue between science and religion will likely yield new sections as well. The second edition will include more in-depth discussions of Gaia theory, Gaian science, Gaian philosophy and Gaian spirituality, as well as connections to “holobionts”.

The set of topics sparked by recently amplified awareness of necessary change for social justice will be added to show how movements for social justice are complementary to and integrated with movements for solving the global ecological crisis. A crucial example of the overlap is the increasing contributions of Indigenous leaders in helping to transform mainstream science. Robin Wall Kimmerer is just one of many sharing Indigenous wisdom and helping to integrate this with mainstream science.

While it may seem a stretch to say that systemic social injustice is linked to the machine paradigm in science, I honestly believe this connection is important and can help with social transformation as well as solving the global ecological crisis. As mentioned above, the machine metaphor which started in science has become nearly fully universalized throughout all of industrial culture. This generic root metaphor of culture ostensibly leads to a machine view not only of non-human nature, but of people and social groups too. This is not to say that oppression, slavery, racism, xenophobia and other forms of prejudice and mistreatment of people started in 1600 with the machine metaphor of Descartes, Newton and their contemporaries. But I am saying that the ROAM paradigm of science very likely has helped such discrimination and injustice become systemic by aiding their continual (and illegitimate) justification in realms like economics, government, education and more.

The mechanistic paradigm is the foundation of a culture where it is common to talk of “using people” for various roles and functions. In addition to the instrumentalist philosophy involved, treating people as machines is implicitly rationalized and justified with concepts and values like efficiency, competition, power, progress, and profit. Using people is even glorified as the trademark of the charismatic, heroic, self-made, rugged individualist whose advances and “job creating” ways are the celebrated focus while their trampling of myriad individuals “on the way up” are ignored. If not fully ignored, such negative side-effects of harm to people are treated as normal and inevitable, just as the entropic way of machines is assumed to hold for our impacts on the environment. With a shift in perspective, it becomes clear that this cultural value is inevitable only when everything is treated as a machine.

The same conceptual model holds for democracy – it seems to become treated more and more as an inefficient and messy aberration from a romantic past. Cogs, gears, motors, cranes, and robots don’t get to vote, and humans who are pressed into service as functional units in the great cultural machine need not vote either. The purpose and value of a machine are not internal, not inherent or self-determined by the machine itself. The purpose and value of a machine are external – they reside in the humans who design and use the machines for various human values and purposes. Likewise, the value and purpose of humans seems to have shifted from something inherent in each citizen, and the “right” of various powers to dictate the value and purpose of people increases while the emphasis on the necessity of democracy erodes, rusts, falls into disrepair.

A similar template of the mechanistic mindset can help to explain the continuations of colonization, slavery, and oppression. And just as regenerative work is needed to restore the wholeness of ecosystems, reparations are needed to restore the wholeness of peoples similarly exploited for other values and purposes not their own.

What Should We Do?

Events since 2018 have helped me to realize that dismantling systemic racism, sexism, genocide and slavery are in the same category, and with much overlap, with the total rethinking and remaking of culture needed to solve the global ecological crisis. I hope that the system of ideas here, offered essentially as a proposal or hypothesis toward rigorous debate and concerted action in service to Life and people, can help to open up new approaches that can eventually lead to success.

Ideas are great, but what should we do? What are the practical implications? Brian has brought up the urgency of this question in recent months, and it has motivated me to try to answer the question. He said it is what students ask, and he (and I) sometimes struggle to know what to recommend for what to do about the complex situation we are in, even after having assembled the detailed and comprehensive story about the two roles of the paradigm of science.

This final section is an attempt to describe actions that 1) would be different than what has been happening so far, and 2) lead to better direction, pace, and scale of change. There are four parts to answering the question, What should we do? These are:

1. How to think – what intelligence, paradigm, mental models are needed. These are covered above
2. How to address the crisis – what orientation, strategy, and framing are needed before acting
3. What to do – this is the action any individual-in-community could do that would lead to success
4. What to recommend others do – for those in positions as teachers, parents, government, and all leaders

For item 2, How to address the crisis, I think the key is to be open fully to starting action with the intention to actually succeed. I have the sense that two things are necessary. First, I think one would have to really, *really* want a solution to the global ecological crisis. We each have to want to succeed so fully as to be willing to do whatever it takes to get to a happy Home. This starting stance is the same as saying that failure is not an option and will not be entertained, accepted, or tolerated. Failure could still happen, but it should not be allowed to happen by giving up, losing hope, or failing to give 110%, and it must be fought to the very end.

Second, in order for the action plan to make sense, to be of value, and to engage with it and give it a try, I think one needs to be creative in several crucial ways. To be mentally or psychologically creative, one has to be very skilled at putting a positive and forward-momentum spin on situations, even those which seem painful, scary, uncomfortable or too hard to bear. I am not only talking about the “sacrifices” of comfort, convenience, amenities, ways of life that we have become accustomed to in industrial culture. I am talking about a kind of stretching even beyond shorter showers, recharging electric cars, using mass transit, eating locally grown food, shrinking one’s carbon footprint, buying fair trade products, etc. I am talking about a full-scale re-imagining of what the world is, what it should be like, what is good and important, and what is right in terms of behavior and relationships.

If you are a professional, and if you can’t really imagine a work life without unlimited flights to international events, or endless supplies of energy and funding for complex projects, or high-tech AV equipment for showing slides and videos in meetings – please don’t let any pre-conceived negative images block you. Instead, creatively and courageously consider both 1) that it could be really great with creative energy applied, and 2) the risk of not solving this crisis is beyond global catastrophe – failure of Life on Earth could be a failure of galactic or even universal proportion. By this stark comparison, the conveniences we have become accustomed to are really not

worth it, and not substantially better than telling stories around a fire, painting pictures, or putting on skins. If needed, imagine reinventing any necessary conveniences so they run on renewable energy, are part of recycling materials processes, and improve the environment over time, just as we know Life does.

Another creative starting attitude includes a twist on the usual call for responsibility. Many sustainability proponents often say in essence that humans are dependent on the Earth, and this dependence is then cited as a rationale for changing our ways. We are dependent, but we also are potentially interdependent, and this type of relationship is to me more motivating, verging on a call to heroism. Just as all Life forms actively participate in maintaining the oxygen atmosphere and climate, humans, too, are conbiotic and integrated with the Life-environment unified whole. We have seen how the human creation of ROAM science, and our own invention of the machine metaphor, has transformed the world so fully that it now literally behaves like a machine, against its own true natural way. But rather than wallow in guilt or despair at what harm we have done, we can turn this harsh reality check into a teachable moment that opens an amazing new potential. If we transformed the world once, we can do it again, this time with loving care and in ways that bring the climate back to stability, begin to rebuild soils, nurture the necessary ecosystemic healing to clean and replenish waters, allow species to rebound, and more.

If this interdependent and co-creative role for humans is not enough, we can even aspire to the semi-independence required to lead Life's exploration and dispersal into space. Sustainers can be key allies of the Transcenders, and both teams will be required for Life to succeed in becoming interplanetary. For Americans and others who love the ideal of independence, so this one's for y'all.

I once heard someone define discipline as "Remembering what we want". This will help us as we pull our Home out of the fire we have started. The "sacrifice" some are talking about as needed, and dreading as if undoable, will be more like change for the better in terms of this version of discipline. The rewards of clarity and cooperation – whether on the Sustainer path or the Transcender path – will far outweigh any discomfort during the transition. A dream or hunch maybe, but worth the try.

OK, so the recommended starting stance is, quoting and borrowing from Stephen Covey, "to begin with the end in mind" (end note 7). Next is what to do with the positive attitude, and the holistic awareness of the two different paradigms and two different hypothetical cultures. Here is what I recommend:

1. Choose a team, community or culture focused on one of the two key Life-environment relations. Are you a Sustainer or a Transcender? I'm not going to talk about how to act to help Transcenders succeed here, but will add more in the revised book. One key recommended principle – Transcenders, to act "in service to Life", cannot act in ways that harm the Sustainer path and future success. You star-traveling Transcenders are going to want to "phone home" someday, so plan ahead to help ensure there is a healthy home to phone.

The rest of the recommended actions are for Sustainers.

2. Since you have chosen the Sustainer path, learn the ways of the Indigenous people of your region. These are the true leaders and authorities on how to sustain Life in your locale. Start by learning whose land you live on. Also learn – from Indigenous people, your own experience, and other allies – the species, water and energy flows, land and limitations, and ecosystem services of your local and regional environments.

3. If you are heavily ensconced in industrial culture, pick a set of rules, guidelines or principles for sustainability and regeneration and begin to transform your own culture. The guidelines can be fairly simple and straightforward, though hard to achieve. Such a simple set of principles is important, since we want to agree to

do them in general, and then leave lots of room for creativity, individual expression and culturally appropriate ways to go with local traditions and specific realities of local environments. Example guides to action are: Use renewable energy, work with recycling materials processes, support biodiversity, and the most general of all – act in ways that improve environmental quality. Also, “always see systems – where things come from and where they go – their time with me is always temporary” (Brian Fath, personal communication). For more specific action guides, one could set goals and act so as to heal and regenerate systems connected to all 10 of the sub-crises we list in our book (see Figure 3 below). Another option is to seek out existing holistic systems like permaculture, regenerative agriculture and others and adopt their principles.

The necessary social principles for acting to solve the global social crisis will be more involved. In addition to healing planetary Life support, we must also dismantle systemic racism, sexism, prejudice and bigotry and make reparations for past genocide and slavery. As above, a good action is to seek out experts and leaders in this area and adopt their principles for transforming social systems for justice, equality, equity and empowerment for all. This is an action step for me, and the results will be included in the revised Ficus and Fath book.

4. For individuals and/or families – pick a set of guidelines as in #3, and then be realistic. For example, make a 10-year plan to transform your family to sustainable living, and go faster if possible and as you gain momentum from early successes.

5. For those working in universities, corporations and other organizations – establish “vertical integration” of sustainability goals. It is a legitimate and real concern, and can be a major blockage, if one fears they won’t get the same rewards and advancement as others if they start to speak and act for sustainability. One solution is to work to get all or most levels in one’s social or economic hierarchy to change in synchrony. That way, action for change will be rewarded, and can help to inspire change in colleagues.

6. For all – set ambitious goals at all levels – global, national, state, county, city, family and individual – and then collaborate and share news and success stories to reach success ahead of the ambitious deadlines. There will be very challenging and necessary work to be sure that corporations and rich nations pay for the expenses of transforming to sustainability and compensate those who have suffered. For those in corporate, banking and rich nation governments, you can get some great PR for paying your fair share – think of the amazing celebrations we can have for getting CO₂ below 350 (or headed there fast), getting to 95% renewable energy, and more – and some of the good will surely will accrue to those of wealth and power who do the right thing during that success story.

7. For scientists and the leading science societies – examine your paradigm of science and understand its role in causing and solving the global ecological crisis. Plan specific steps to transform your own operations of teaching, research and communication so that they run on renewable energy and within recycling materials systems, and lead to verifiable improvement in environmental quality. Do not assume any sort of special status based on your work to advance knowledge, even if you work in ecology, environmental science, sustainability or related fields. Be aware that if you use an excuse such as “my work is special and has to be done”, everyone else in every other field can use the same excuse for not transforming to sustainability.

We address other key action steps in the book, including essential changes to systems of money, a new mindset with respect to “development” of land, and more.

Finally, what are helpful, valid recommendations if someone you know asks what to do? Besides all the thoughts and suggestions above, I would suggest some possible questions one could pose as ways to inspire the reflection, internal dialogue and insight that could get the transformation started. Thought-provoking questions can lead to new questions and then new options – this is the real power of reframing and paradigm shifting.

For example, if someone asks What should I do?, you could ask:

1. What feels like the more natural home for you – Earth or somewhere beyond Earth? To choose what to do it is important to figure out where you want your permanent home to be. The Life-environment relation is unique for each environment.
2. Tell a brief story of the Sustainers and Transcenders. Then ask one or more of these:
 - a. Should the Transcender folks agree to pause their mission and operations until we get the crisis solved on Earth?
 - b. Should the fossil fuels be split 50/50 for the two cultures? Or should all the fossil fuels be allocated to the Transcenders since the Sustainers won't need them over the long term anyway?
 - c. If a group of Indigenous people, similar to Sustainers, and a group of space exploration people, like the Transcenders, had a meeting and discussion, what would be the areas of agreement and disagreement? How could agreement and cooperation be achieved?
 - d. Does space exploration feel like running away from problems on Earth? If billionaire exploitation of space for personal ego and profit is not part of a Life-serving and humanity-serving space mission, what would be?
3. Tell a brief story of the ROAM and HOL science paradigms, and then ask any of these:
 - a. What will it take to reform science so that it can truly serve Life rather than threaten its existence?
 - b. Do we have time to revise page 1 of Biology 101 in all textbooks? What is the fastest way to learn something profound and complex for an entire Earth family of 8 billion people (or at least the billions living in industrial cultures)?
 - c. Are there any ways in which machines can be sustainable?
4. Are you worried about giving up conveniences and comforts that are embedded in industrial culture? Would change be worth it if the result included more time with friends and family, more time in nature, more simplicity, more self-renewal, more freedom from attachment to possessions, working less, a clean environment, progress toward peace and justice, and a sense of abundance instead of fear of scarcity with associated conflict over resources?
5. A last comment and question combo could be – I have a plan for my own transition to sustainability. Would you like to see the actions I will do?

This last option follows the principle we cite in the book, from Albert Schweitzer, who said, paraphrased: “For influencing others, example is not the main thing. It is the *only* thing.”

In conclusion, I hope this essay may serve to suggest that a successful future is possible – even better, two successful futures! Our 2018 book, future revisions, essays like this, and manifestos of others, no matter how wise or well-intentioned cannot possibly spell out the solution like an easy-to-follow recipe. As in the story above, it will not mainly be a mechanical story about a mechanical world, with control and purpose in our hands, and the only need to find the right dials, levers and new technology. It will be a relational story about Life and Life-environment relation, including the Human-environment relation, and human-human relations. In this story, for travel tips for the journey, I offer the insight of Bob Ulanowicz that ecology is fundamental science, not derivative of physics. Also, the Life-environment relation and Life’s anti-entropic improvement of its environment is as fundamental as the 2nd Law of Thermodynamics. The Golden Rule may in fact be the Golden Law – as you do unto “other”, any “other” including the environment, so will be done unto you.

Our commonsense and assumed truths can and must change. Now many are looking at our situation, looking at the ways and lifestyles of industrial culture, and asking, How can we make this sustainable? Because this seems genuinely futile and impossible, many have given up on the concept of “sustainability” entirely, and moved on to “regenerative”, “circular economy” and other new ideas. Sustainability is deeper than we have given it credit for. Life is either sustained or there is only Death and Non-existence. A new option is to observe and understand what in the universe is sustainable, and then ask How can we live, learn and love within that sustainable cycle?

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End notes

1. Fiscus, D. and B. Fath. 2018. Foundations for Sustainability: A Coherent Framework of Life-Environment Relations. Elsevier / Academic Press.
2. Kuhn, T.S. 1962. The Structure of Scientific Revolutions. University of Chicago Press, Chicago, IL, 264 pp. ISBN: 9780226458083.
3. Ulanowicz, R.E. 2009. A Third Window: Natural Life beyond Newton. Templeton Foundation Press, West Conshohocken, PA, 224 pp.
4. Rosen, R. 2000. Essays on Life Itself. Columbia University Press, New York, NY, 416 pp. ISBN: 9780231105118.
5. Allen, M.S. 2014. Marquesan Colonisation Chronologies and Postcolonisation Interaction: Implications for Hawaiian origins and the ‘Marquesan Homeland’ hypothesis. Journal of Pacific Archaeology, Vol. 5, No. 2.
6. Eriksson, A., L. Betti, A.D. Friend, S.J. Lycett, J.S. Singarayer, N. von Cramon-Taubadel, P.J. Valdes, F. Balloux, and A. Manica. 2012. Late Pleistocene climate change and the global expansion of anatomically modern humans. Proceedings of the National Academy of Sciences (PNAS), Vol. 9, No. 40, p. 16089–16094.
7. Covey, S.R. 1989. The Seven Habits of Highly Effective People: Restoring the Character Ethic. Simon and Shuster, New York, NY.

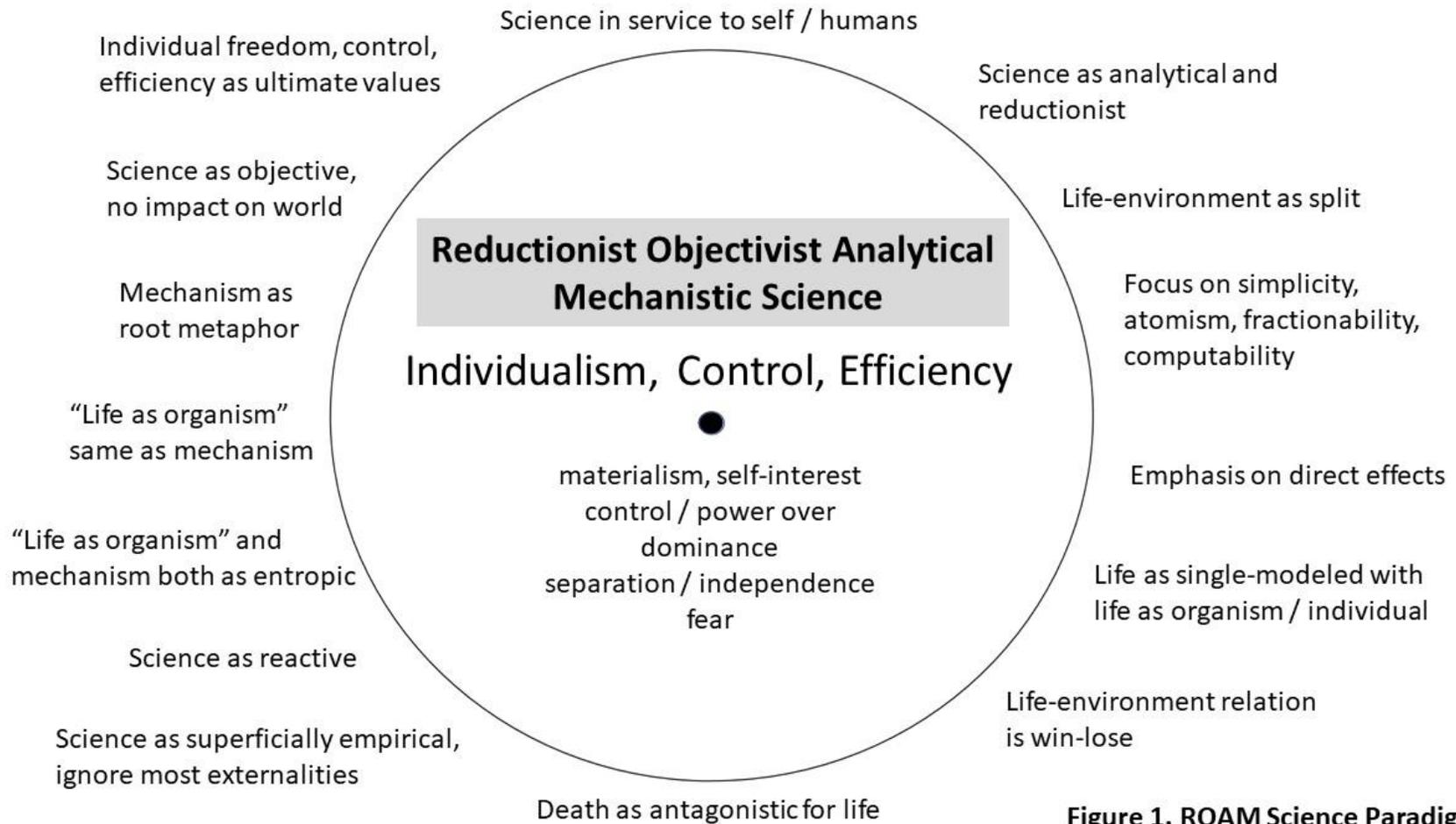


Figure 1. ROAM Science Paradigm

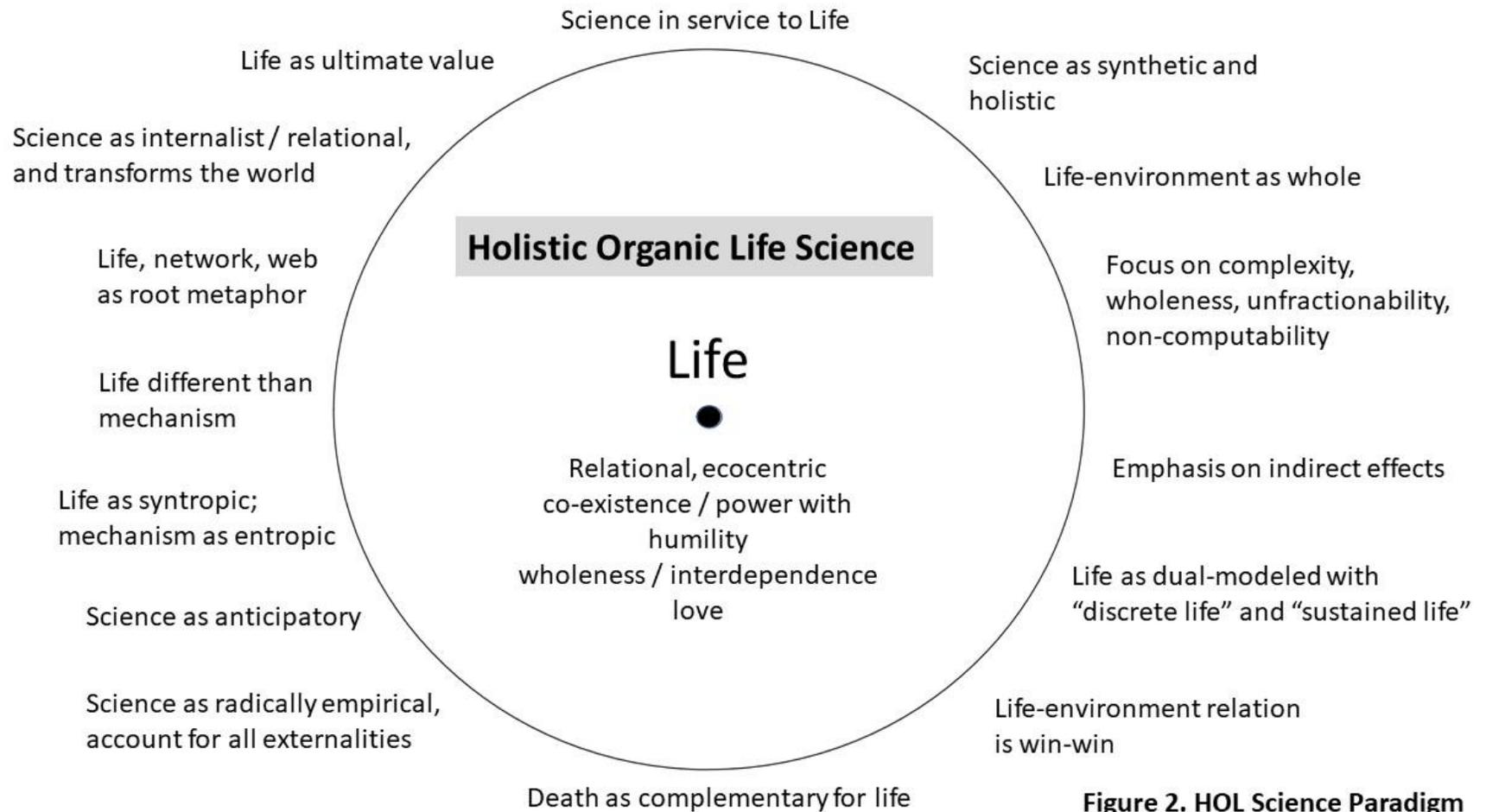


Figure 2. HOL Science Paradigm

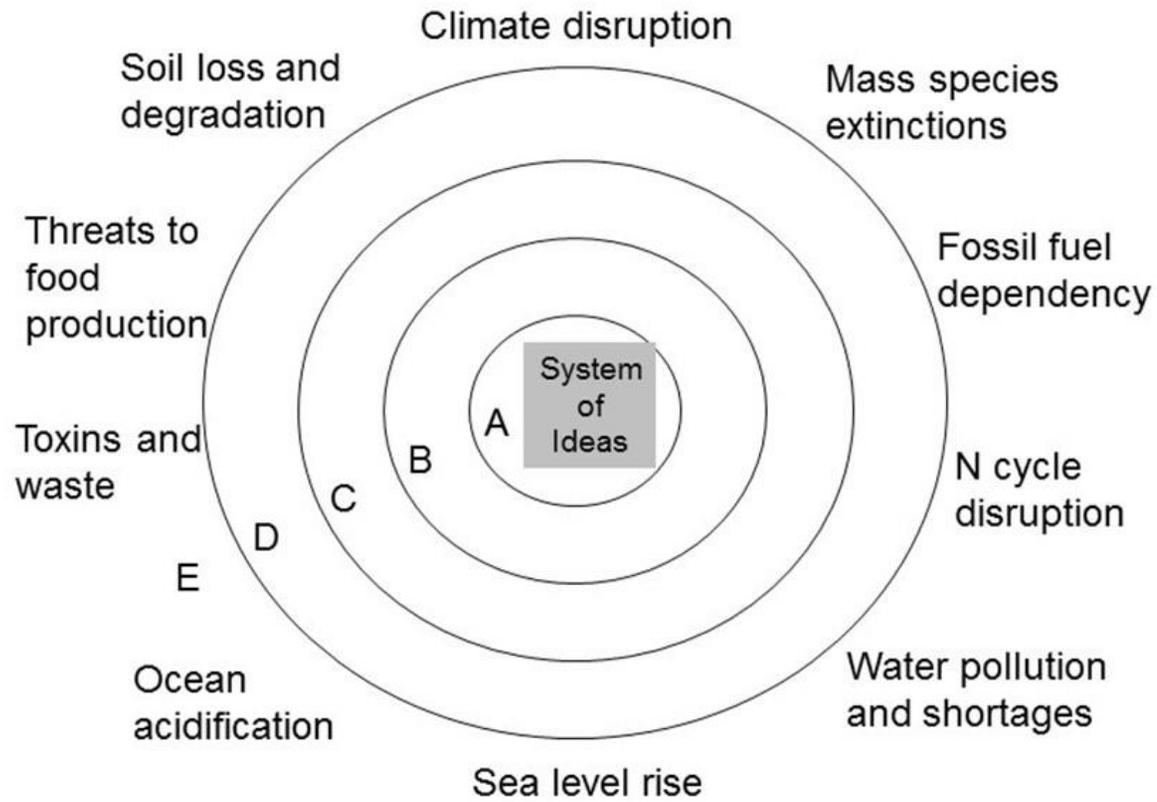


Figure 3. From Fiscus and Fath 2018