Campus Landscape as Urban Silviculture.

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For:

Dr. Hansis, ENV-411

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Problem Statement

General Environmental health is poor on campus. This poverty is manifest in the thick overgrowth that limits sunlight and facilitates the unhealthy accumulation of dead plant matter and mold in the tree canopies. This problem is endemic to the general area in which the campus is situated. This unhealthy state is a result of the lack of awareness of proper landscape maintenance on Humboldt State University's campus.

Definition of the range of 'environmental health', from 'healthy' to 'dead':

Healthy: Landscape dominated by small, screaming animals. Forest canopy is high and fruitful and tree-form is straight and strong. Surface water is cold and turbulent and is wicked in to the forest duff.

Dead: Bare soil open to full sun.

Background Information

Poverty is a state of mind. We are a product of our environment so if our environment is poor, it reflect on us. People don't get out of poverty either because they don't see the way out or that they don't see the poverty. Relative to our landscape problem both are true. People have forgotten the sights, sounds, and scents of a healthy environment and take what exists for granted.

As we look around Humboldt State University campus we may be struck with awe as we stare at the forest and vegetation which surrounds the institution. To many, allowing trees and brushes to grow freely is seen as a beautiful method of allowing the land the opportunity to care for itself. But when comparing it to what we are taught about sustainability and ecosystem functioning, the land looks unhealthy. The unhealthy state is due primarily to the current methods of landscaping and "caring" for the land, as well as the public's education and knowledge concerning landscape health.

Currently, landscape management consists of trimming vegetation from pathways and buildings, then removing these trimmings to be disposed of offsite. The removal of this vegetation from its original location is one of the main contributing factors to the unhealthy state of the landscape. The natural cycling of nutrients becomes disrupted and the soil suffers as a result. By allowing trimmings to remain on site we can decrease soil compaction, erosion, and nutrient loss. The trimmings would form a ground cover that would also be quite effective in

starving out invasive species. To adjust our work to a healthy practice, trimming style needs to be adjusted slightly. Instead of cutting off branches and vegetation from where they intrude on pathways, it would be much better to remove those branches directly from the trunk so that the plant can grow tall, straight, and strong. Many trees on the HSU's campus would benefit from the removal of branches from the lower trunks and general thinning of upper branches. This will help increase biodiversity and landscape tiers and clean up the unhealthy accumulation of decaying dead matter in the tree canopies.

The problem we see is that the landscaping practices are maintaining the land and vegetation in a less than desirable state. With very small changes our landscaping practices, the general health of our environment can revert to a vibrant and healthy ecosystem.

One of the biggest obstacles is the perception of the majority of the public that does not notice the ill health of the landscape. Another obstacle is that current landscaping techniques are accepted, as are their results, which consists of unnaturally clean soil layers and mulch. This landscaping method gives a "clean" appearance which has become the accepted norm.

The current situation is one in which society has accepted that landscaping, especially around human institutions, is primarily used for ascetic appeal. Many people enjoy seeing a freshly cut lawn or a flower bed with little debris. Also, many people are disgusted when they walk by and see tree branches being cut, without even considering why they are being removed in the first place. This latter perspective is especially prevalent at HSU. Many students, as well as faculty and staff, feel that leaving the landscape to naturally develop, as it did before humans interacted with it, is the best management for the land itself. However, what must be acknowledged is the fact that the land will never be able to develop as it had, because humans have already caused enough disturbances that will affect the land for years to come. Humans have been interacting with the trees for thousands of years and they have evolved with those interactions so removing that interaction has a negative effect on the ecosystem. By increasing the public's knowledge of ecosystem health, these perspectives will shift and people will begin to see the landscape differently.

This shift in consciousness was illustrated by the native plant restoration which has been carried out over the past few years on campus. Since the education about native plants and why they are beneficial has increased, the perspectives on landscaping have changed. Now, the dominant perspective is one which sees non-native species as blight on the landscape. No matter

how brilliant or beautiful a plant may be, if it is a non-native species it is usually met with some hostility and attempts to remove it from the ecosystem are common. We are attempting a similar educational campaign to change the public's view of landscaping further. One of the main differences between the restoration of native plants and our proposal for healthy landscaping is that we are not concerned with species eradication, just health. We acknowledge that ecosystems are constantly in a state of flux and that they have natural processes which are designed to return the land to a state of health. What we intend to do is facilitate these processes as much as possible in order to establish a healthy ecosystem. Instead of removing all traces of a non-native species, which requires significant energy expenditures and disturbs the land, healthy landscaping would facilitate the growth of desirable species and at the same time degrade the ability of non-desirable species to exist. This can be accomplished a variety of ways, one of which is to allow any trimmings to cover the soil where invasive are growing, as mentioned earlier.

At this time in human history there is an abundance of intellectual light informing us on everything from the inner workings of the body to the outer workings of the universe. Wrong information that is deliberately false and coined as entertainment is popularly prevalent and there is general confusion over right and wrong. The philosophy of how we understand our world informs how we view the world we see. One of the essential components of this modern philosophy is 'Natural Selection". Somehow, 'Natural Selection' has become to mean 'Random Selection' and we now view ourselves as an 'outside observer' to that 'Random Selection'. We argue here that 'Natural Selection' has two components, 'Random Selection' and 'Intelligent Selection'. We, as humans are the best equipped of all organisms to exercise 'Intelligent Selection' to steer our environmental health through the random events that disrupt it.

Goals:

- Shift popular view of 'self' from 'Outside Observers' of nature to 'Intelligent Selectors' of nature.
- Create mechanism to allow citizens to exercise their 'Intelligent Selection' toward healing of the land in and around human settlement.

Objectives:

- Develop intelligible literature that illustrates the healthy urban landscape 'how to get

Some of these are means

there from here'.

- Develop interpretive display for the urban landscaping demonstration site below the BSS building
- Get official recognition of the urban landscaping demonstration site and delegate stewardship of the site to a student club.
- Organize volunteer days to help HSU grounds-management department tackle some long neglected areas on campus.
- Interview in local media to gain publicity for the practice.

Formulating Alternatives

To succeed in meeting our goals, we must develop a range of alternatives that may be able to satisfy our objectives. One method we can choose is a no action alternative. However, this would in no way fulfill our goal since it would only allow the continuation of unhealthy landscape practices. Therefore we must formulate different alternatives that we believe will be capable of meeting the objectives which we have set forth.

Alternative 1

Have the demonstration site officially established as a permanent research site that would be off-limits to regular landscape maintenance. This would include securing the stewardship of the site with a student club such as the Natural Resources Club. To establish the site as a university recognized research site, we will request written support from organizations such as the Associated Students, the Center for Indian Community Development, and the Campus Center for Appropriate Technology among others who will be able to incorporate the site and its associated landscape work into already existing educational programs. Once we have gained written support, we will request that the Vice President of Administrative Affairs designate the site officially for student stewardship. Once this has been accomplished, we will use a part of the new gallery on the south-west side of the first floor of the Behavioral and Social Sciences building to house an interpretive display of the demonstration site.

Alternative 2

Have the demonstration site officially established as a permanent research site that would be off-limits to regular landscape maintenance. This would include securing the stewardship of the site with a student club such as the Natural Resources Club. To establish the site as a university recognized research site, we will request written support from organizations such as the Associated Students, the Center for Indian Community Development, and the Campus Center for Appropriate Technology among others. Once we have gained written support, we will request the Vice President of Administrative Affairs to designate the site officially for student stewardship. Once this has been accomplished, we will establish an on-site interpretive display.

Alternative 3

If we are unable to officially establish the site with the Vice President of Administrative Affairs, we can still have the Natural Resources Club maintain stewardship of the site. This alternative could still include an interpretive display, either on-site or elsewhere.

Alternative 4

This alternative includes no student stewardship and no officially recognized site. It does include an interpretive display, either on-site or in the gallery.

Weighing Alternatives

Alternative 1 is ideal because it provides a protected living display, as well as an interpretive display. The site could be used for multiple educational purposes. The continuation of this work on the site will provide valuable research data which can then be used to extend healthy landscaping methods. An interpretive display inside the BSS building is ideal because it will reach people who may not pass by the site, but could easily walk to it from the interpretive display. The site itself would have a smaller sign that would direct those on-site to the interpretive display for more information. This is our preferred alternative.

Alternative 2 is somewhat less ideal because the on-site interpretive display is much more limited in the amount of detail it is capable of displaying. Also, this display would also be much less visible than one in the gallery. This alternative would still provide innumerable educational and research opportunities, however widespread awareness would not be as great as Alternative 1.

Alternative 3 is far from ideal. The site's continuation would be constantly in jeopardy of interference from plant operations without official recognition from the University. The Natural Resources Club would still be able to carry out stewardship of the site; however they may not feel comfortable doing so if it is not sanctioned. This alternative would provide very limited, if any, educational and research opportunities and would make no attempts to spread awareness of the state of our landscape.

Alternative 4 is less than ideal due to the fact that there is no stewardship and with continued neglect the landscape would become overgrown and the demonstration site would cease to exist. An interpretive display would be almost pointless, and would only generate limited awareness of the issue. Only people walking by the display would see it and only those who choose to stop would have any real understanding of healthy landscaping.

Implementation Strategy

To implement this plan we need the following three things.

1. Get commitment from a student club and a faculty member to assume stewardship as soon as permission is granted.
2. Vice President for Administrative Affairs protects the site from construction and landscaping crews by designating it a protected "Urban Silviculture" research site.
3. Obtain permission to set up an interpretive display in the BSS gallery overlooking the research site.

Implementation:

1. We attended the NR club meeting and showed them before and after pictures of the research site and described the stewardship responsibilities. The club responded favorably and agreed to take on the project if the site receives protection. They also requested that we provide a written stewardship guide.
2. We plan to make a presentation to the Vice President for Administrative affairs and request that the site be protected by the university by designating it as an "Urban Silviculture" research site. Prior to meeting with the vice president, we are currently working to gain political support for our proposal to aid the vice president's decision making process. Here is a list support we are working to generate:
    a. Thomas Dewey, University Chief of Police has toured the McKinleyville Land Trust demonstration site about a year and a half ago and was very impressed. He also toured the on campus demonstration site before the work was done and gave his approval to creating the demonstration site. He has voiced a favorable opinion of the project and said that he would be happy to be a witness but due to his position he can not be an opinionated advocate.
    b. Doug Kokesh, University Grounds Manager, toured the demonstration site with Chief Dewey before work was started and granted the permission needed to develop the demonstration. He has been very approachable and generous with his time and authority, however his authority is limited and he directed me to seek Vice President Carl Coffey who has greater authority over ground usage.
    c. Cheryl Sidener chairwoman of the Weott offered to advocate for the project and referred us to seek additional support from Jacquelyn Bolman, director of INRSEP (Indian Natural Resource Sciences and Engineering Program).
    d. Jaclyn Bolman toured the site and is now a strong advocate for the project.
    e. Tallchief Comet, university Sustainability Coordinator tours the site and is now a strong advocate of the project.
    f. We met with the Clubs Coalition but they seemed unsure about what they can do and asked me to send them something electronically for consideration and at the end of the meeting, none of them were willing to take the 20 second walk from CCAT to the site for an on-site brief. This group does not seem worth pursuing.

g. We attended an AS council meeting on October 22nd, 2007 to give a brief description of the project where the council was shown before and after pictures of the research site during the public comment period. On Wednesday October 31st we submitted to the AS a video description of the project and requested they vote to support a statement that recommends to vice president Carl Coffey to provide institutional support for the project by designating it as an official "Urban Silviculture" research site under the stewardship of the Natural Resources club.

3. Cheryl Sidener referred us to Zoe Devine, who is in charge of the BSS Gallery. Zoe will be on campus after October 31st. We talked to Zoe and she informed us that the area designated for the BSS Gallery is not planned to be used any time soon. She was not able to give us an estimate of when she thought the gallery would be in use, but told us to keep in contact to talk to her about it in the future. We will continue to pursue this option, as well as any others that may provide an opportunity to set up an interpretive display elsewhere.

I would like to have seen more results not just what you did

Monitoring and evaluation plan

We expect this to occur on several levels. The most constant monitoring and evaluation will be done by the Natural Resources Club, which has been designated stewardship over the research site. Monitoring will also be done routinely by grounds management who will have a communication channel with the NR club stewards. Moshe plans to continue with time laps photography of the site an order to map long term events. And the call is still out for faculty who would be willing to assist in the monitoring and interpretation of specific environmental health indicators such as soil pH levels, biomass accumulation, and ground water quality, among many others. These measurements could easily be incorporated into numerous lab course works which should only assist in learning here at HSU. The major trends we are attempting to achieve with this form of landscaping are increased vigor, resilience, biodiversity, ecosystem services, and variety of uses while decreasing the amount of energy expended to maintain these landscapes as

well as decreasing their negative effects on human health and other ecosystems (Rapport, et. al., 1998).

The enclosed videos explain the landscape work better. It is a time lapse video, so please open it using Windows Media Player and select View and under that select enhancements and select Play Speed Settings, this will provide a speed control panel. I recommend watching at about 10x speed.

Moshe will be presenting these videos at the Synergy fair in Arcata on Saturday November 17 at 5pm and at the third annual NORML day conference in the KBR on Wednesday November 28 at 2pm.

By presenting these materials we can get more people to monitor the work, evaluate it, and provide opinions and suggestions. Until we have critical feedback on this site and our proposed project we are not able to begin a full research project on the site. We do not claim to be experts in the field of ecosystem health, only concerned students with a background in natural resources and energy resources. Therefore, there is a need to be cooperating with experts in the various disciplines of natural resources and biology.

Conclusion

At this point in our project, we have obtained the Natural Resources Club's commitment to carrying out stewardship of the site once official recognition has been obtained. We have ample support for the research being done on campus, and are only in need of Vice President Carl Coffey's approval. We will not approach V.P. Coffey until we can secure a faculty representative to endorse their support for our project. Moshe is currently attempting to assemble his graduate's panel for the same purposes, and once this has been accomplished, a meeting can be scheduled with V.P. Coffey.

Appendix A: Pictures

Picture of mold growing in tangled branches of brush allowed to grow uncontrolled on the research site before landscaping work was initiated in January of 2007. Unmanaged landscapes are very susceptible to mold due to the low levels of sunlight and air circulation allowed by the

dense vegetation. These molds contribute to a degraded air quality on campus and in human environments all over.

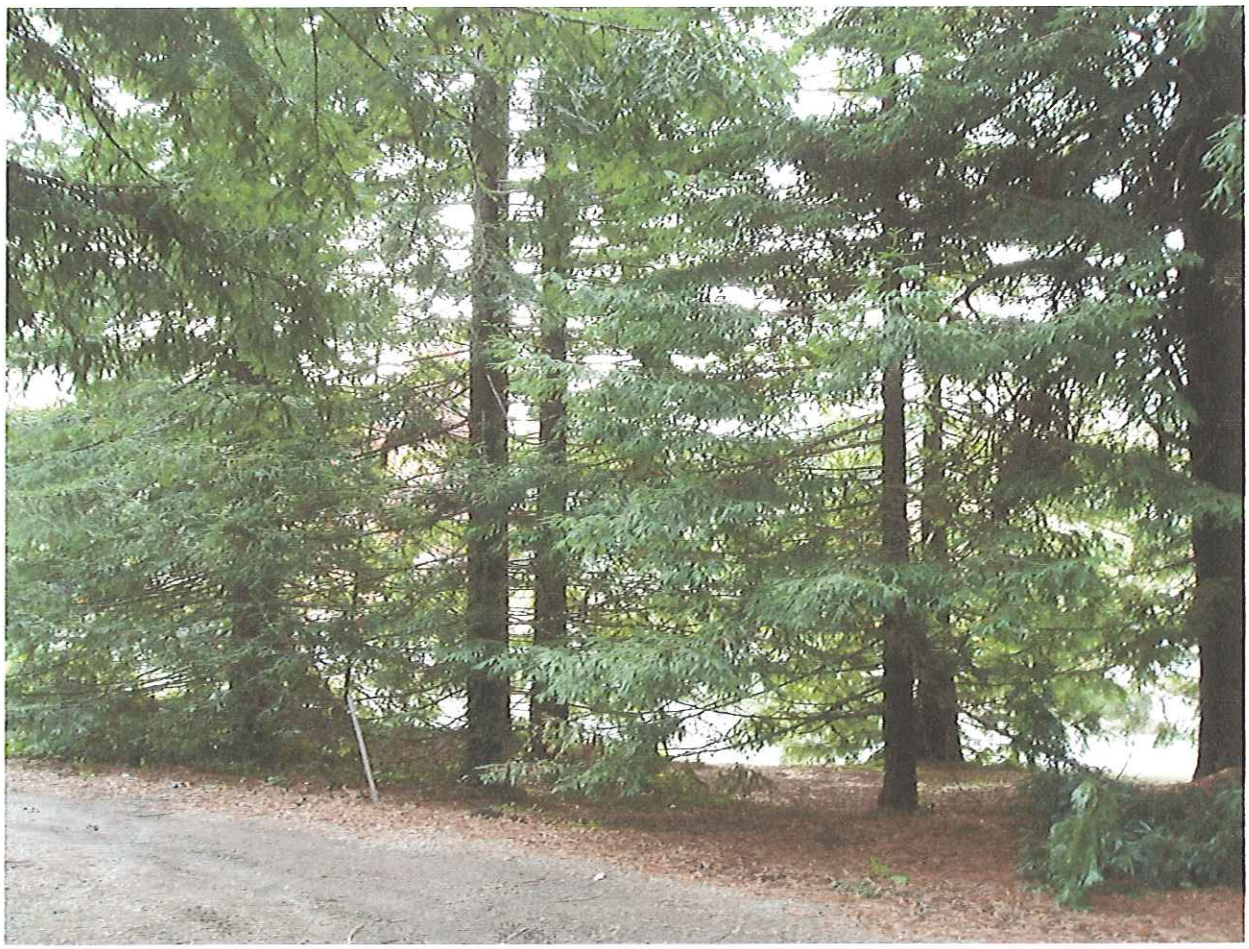
Picture taken in January of 2007 before landscaping work took place on research site

Picture of same location as above photo, but after initial landscaping work was still in progress.

Dumping ground used to store landscape clippings before they are trucked to be composted. This removal results in great expenditures on fuel and at the same time it is not allowing nutrients to be recycled into the ecosystem that had utilized them. This only increases the need to use additional fertilizers to supplement the soil and mask the unproductive state of the soil and the ecosystem itself.

- Are the chips used on campus?

Picture of the walkway behind the Natural Resource Sciences building. Unmanaged growth blocks sunlight from walkway. This is seen all around HSU and is a major contributing factor to the dark and secluded areas found all over the campus. These dark and secluded areas are not safe to be alone and only facilitate unwanted activities to occur.



Branches left untrimmed all the way down trees to the ground level. Some of these trees have reached heights of 50 feet and only maintain the branches on the bottom because they have not fallen off. If these branches are removed, the trees can put more energy into growing straight and strong. Also, the space where the branches now occupy could be supporting an understory which would increase biodiversity and productivity of this site.

These are the tools that were used to complete the landscape work at the research site. They are very low-tech and extremely simple to learn how to operate properly and effectively. Other tools may be needed for certain activities, but almost all can be accomplished with these two alone.

Appendix B: Economic Analysis

Here are the estimated costs that would be incurred if Plant Operations would have done the removal of vegetation on the research site. These estimates were provided by Doug Kokesh

Site area: 9666 ft^2

Hourly area covered: 110 ft^2/hr

Hourly operating cost: $35.91/man hr (inclusive of equipment costs, gas, salaries, ect.)

Man hours required for site: 87 man hours

Total costs: $3,124.17

Here are the estimated costs that would be incurred if the work done by Moshe had been charged to the University.

Site area: 9666 ft^2

Hourly area covered: 343.5 ft^2/hr

Hourly operating cost: $35.91/man hr (inclusive of equipment costs, gas, salaries, ect.)

Man hours required for site: 27.66 man hours

Total costs: $993.27

Total net savings: $2,130.90

Appendix C: Timeline

2007-01-02	Permission granted by Plant Operations to begin work on research site below BSS building.
2007-02-16	Site work completed
2007-02-22	Presented research materials.
2007-03-16	Obtained cost estimates from Grounds Manager, compared these figures with research work site figures.
2007-08-20	ENV 411 begins.
2007-08-26	Met with Joan Dixon at Organic Planet Festival in Eureka.
2007-09-04	Gave interview with Joan Dixon.
2007-09-07	Toured Joan Dixon's property and gave diagnosis.
2007-09-10	Completed final version of Dixon article.
2007-09-11	Sent copy of Dixon article to Dr. Hansis.
2007-09-17	ENV 411 group formed, toured Mckinleyville site.
2007-09-21	Trimmed acacias behind CCAT house, attended clubs coalition meeting. And begin treatment at Joan Dixon's property.
2007-09-28	Expo invites sent out.
2007-10-03	Toured Fieldbrook apple farm.
2007-10-12	Attended BSS building dedication.
2007-10-17	Videotaped field work at Dixon's property.
2007-10-19	Met with Cheryl Sidner at HSU research site, she refers us to Zoe Devine and Jacquelin Bolman.
2007-10-22	Attended AS meeting and gave brief introduction to work and what would be presented at the following meeting.

2007-10-24 Met with Natural Resources Club to discuss their stewardship over the site if official recognition is obtained. They express their support and willingness to do so.

2007-10-25 Met Dr. Cliver at NORML table.

2007-10-26 Attended clubs coalition meeting, invited members to view research site, only sustainability coordinator came and express his support.

2007-10-29 Toured research site with Jacquelin Bolman.

2007-10-31 Wrote letter and submitted a 10 minute video to AS, was denied any discussion because the vote was not a resolution.

2007-11-05 Presented to AS, no vote was taken because they state they can only vote on resolutions and nothing else.

2007-11-07 Attempted to schedule appointment with Zoe Devine, she tells us to find her "sometime on campus", informs us that BSS gallery is not even a "blip on her radar"

2007-11-13 Met with Doug Kokesh and gave him copy of 10 minute video, discussed it with him and he said he would pass it on to Sustainability Coordinator, Tallchief.

2007-11-14 Filmed "Urban Silviculture Tour" which shows site and explains what and why the work was done.

2007-11-17 Presented research at the Synergy Fair.

2007-11-26 Gave copy of 10 minute video to Jacquelin Bolman.

2007-11-29 presented research at NORML Day.

2007-11-30 Gave copy of NORML Day video to Jaquelin Bolman.

2007-12-03 Presented research experience to ENV 411.

Appendix D: Literature Review

Willers, Bill. 1999. *Unmanaged Landscapes.* Island Press.

This book was overwhelmingly negative, loose collection of unconvincing arguments. The majority of the essays discussed the problems of unhealthiness, but never attempt to offer any solutions for these problems.

Honachefsky, William B. 2000. *Ecologically Based Municipal Land Use Planning.* Lewis Publishers.

This book contains a very strong and opening sentence and then delves deep into the environmental problems that humans have created. Chapter 3 starts to look at specific problems, but then shifts to a discussion about planning and regulating without ever discussing what makes a good plan or regulation. The next 4 chapters deal with regulation and planning, but never address how to actually reverse the unhealthiness. The book then begins to describe actual ecosystems and what unhealthiness looks like. There is no mention of what good health looks like and absolutely nothing about methods to fix this unhealthiness.

Rapport, David, Constanza, Robert, Epstein, Paul R., Gaudet, Connie, Levins, Richard. 1998. *Ecosystem Health.* Blackwell Science Inc.

This book starts out with a very encouraging preface. It states that earlier predictions of impending environmental destruction have already come to pass, and that the cause is in both our institutions and our intellectual heritage. The solution that is proposed for this is "Therefore, as we confront the substantive issues of ecosystems as wholes, we also have to explore the methodological problems of this emergent field and examine ourselves as participant-observers, questioning our perceived ways of doing things and the obstacles presented by the way intellectual life is structured." The book then states "This book is not about failings, but rather opportunities for our future."

The end of the Ecosystem Pathologies section in chapter 1, the author makes a statement which is indicative that this book will be more of the same, in that it will focus on doing less negative impact, but will not discuss how we can not only slow down these trends, but reverse them. The statement is this: "It is far better, however, to design new approaches to environmental management that focuses on ecosystem health and to implement ways and means of ensuring that ecosystem health is not further compromised by human activity. In other words the action must shift to prevention." While this is a valid point, it is not the only option in repairing ecosystem health.

Chapter three is titled Defining Ecosystem Health, but it falls short of its title. It attempts to draw a parallel between ecosystem health and modern medical practices, but throughout the chapter it only makes vague mentions of health attributes. It never clearly defines ecosystem health indicators or how to measure them.

In chapter 4, David Rapport begins with a string of what seem to be false statements: "Ecosystems are not organisms and do not behave like organisms.", "No indices of ecosystem health exist nor is developing any possible.", "The use of metaphor in political debate masks the value judgments that were made-judgments are policy choices, not scientific choices." All these statements are contradicted in other literature, most of which is grounded in firm scientific data. The last statement he makes seems to be offensive to the scientific community: "The roles of science and scientists in defining ecosystems or ecological health are contentious. To categorize something as health requires an implicit determination of the desired or preferred state." He closes chapter 4 with more discussion about health attributes, but never in full description. He believes that ecosystem health is something that the medical community should tackle. His view of ecosystem health is heavily based on the effects the environment has on human health, which we see as only one component of ecosystem health.

In chapter 11the author lists some questionable practices for analyzing ecosystem health. There are statements such as "Newly available mathematical tools allow these restrictive assumptions to be relaxed." This puts a lot of faith into computer modeling, many of which have proven to be unsuccessful at predicting complex ecosystem processes.

Chapter 14 starts going into risk and how risk of damage is attributed to our behavior, but does not provide ways to minimize our exposures to these risks.

Chapter 15 begins to discuss the attributes of good health, but quickly dissolves into obscurity over the concept of sustainability without ever describing a healthy ecosystem. More troubling is the definition of sustainability given in this chapter: "Sustainability means avoiding extinction." This is the lowest possible goal for sustainability, and will not produce healthy ecosystems in any way. It will only produce barely functioning ecosystems.

The end of this book contains various case-studies which document clearly how we have caused our own destruction. It discusses legislative measure that were passed in response to these environmental disasters, but never discusses the basic needs of these ecosystems to return to a state of full health.

Craik, Kenneth H., Zube, Ervin H. 1976. *Perceiving Environmental Quality.* Plenum Press.

This was an interesting book to review because it is a glimpse into some of the earliest institutional thought on the environment. The book does not provide any significant information on ecosystem health, however, because it is not even a concept which was being discussed at the time. The book is concerned primarily with 'perception" of humans. It discusses what is pleasant to see and what is not, how people perceive pollution, and what kinds of sights or sounds annoy them. The book was more about gauging the publics awareness of the environment rather than a study of environmental health.

Jorgensen, Sven Erik. 1997. *Integration of Ecosystem Theories: A Pattern.* Kluwer Academic Publishers.

Great book. The author skillfully places ecology in its scientific context by tying it into its sources in Biology, Thermodynamics, Physics, Particle-physics and Cosmology. Then the author clearly situates ecology within thermodynamics and clearly illustrates its limitations as well.

In the beginning of chapter 4 I see what appears to me as a conceptual error. The author refers to the law of conservation of energy and conservation of mass. Conservation of energy is the general case that applies universally. Conservation of mass is not actually true, since most matter has some fluctuation is mass due to absorption and emotion of energy. But conservation of mass can be used, if the changes in mass are negligible or if conservation of Nucleons or baryons were of only interest. But in the case of this book the mass fluctuation can not be considered negligible due to the large amount of radionuclide activity in our ecosystem, such as Radium, Radon and Carbon 13. If I am correct, conservation of energy holds true while conservation of mass does not. However, I saw no subsequent argument in this book that would be undermined by this error.

The author beautifully shows ecology in relation to classical thermodynamic studies and shows the limitation of the second law of thermodynamics, that applies when the system is near thermodynamic equilibrium. But living systems exist far from thermodynamic equilibrium. So the author introduced me to a new factor, Exergy or negative entropy and he shows how it is information that drives exergy to maintain living systems is a state far from thermodynamic equilibrium. I find this concept to be one that I've been trying to imagine for a couple of years now, and this author really brought it home for me in a solid logical form. However, I think that instead of using "information" as the term that drives exergy, I think the term "Intelligence" would work better. To use the authors example, the pheromone only has its power if the right moth exists, otherwise it would be like a key whose lock gas ceased. Unintelligible information is just noise no matter how articulate. I think that substituting the term intelligence for the term information would continue to hold up the argument for exergy and also fill some of the holes discussed in later chapters.

The author does a great job laying out the separate ecological theories currently employed in ecology. These are the Network, Hierarchical, Utility, Indirect affect, Ascendancy, Catastrophe and Chaos theories. In the last chapter the author how all these theories are appropriate for use simultaneously since they all work under different ranges and that there is very little intellectual conflict between them. And this he explains, that all the theories are true and that we just don't have yet a whole theory that explains all the interrelations. He then explains that exergy should be included as a universal 4th law of thermodynamics for all systems (living or not) that are far from thermodynamic equilibrium. I didn't quite follow him there but it makes good sense to me for living systems.

What I was really looking for in this book review, was a definition of good ecological health. And on page 266 the author delivers in the following three point summary:

1) *The optimum operating point is on the original thermodynamic branch. This means that the lower levels (1 to 4) of the regulation mechanism presented in table 2.1 can cope with the environmental change*
2) *The new optimum operating point is on a bifurcation from the original thermodynamic branch. It will correspond to regulation mechanism level 5 in table 2.1. An example is the change in species composition of phytoplankton as a response to higher or lower inputs of nutrients to a lake.*
3) *The new optimum operating point is on a different thermodynamic branch and the system undergoes catastrophic reorganization to reach it.*

He gives a longer more articulate description of ecosystem health on page 288 under Ecosystem Properties. I strongly recommend this book, it is rich in factual information and reference, follows through with well defined logic that flows from start to finish.

Conclusion:

What none of these books address books address is what to do about the ill environment described in the first four books of this review. The first four books, I think were all aiming in the right direction but none of them got off the runway. The fifth book, I think is off and running on the solid logical foundation of science. What it is missing is the final connection to our senses; the smells, sights, sounds, feel and taste of the ecosystem. I strongly believe that if Living Intelligence and our senses were factored into the picture we can tie all the theories into a whole earth perspective that will enable us to steer this system safely through this well described period of catastrophe, and establish the conditions for good health. With these new attributes we will also be able to see more clearly the foundations under science such as air, fire, water, earth, (metal). And we can receive the tricks of good healthy living that is our heritage. As Dr. Jorgensen argues that we are at the receiving end of about 3.5 billion years of pass-through exergy.