ADJUSTING LAW TO NATURE'S DISCORDANT HARMONIES

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INTRODUCTION

This article focuses on the implications of new ideas in ecology on law and policy. There has been a revolution in ecology, in fact in all environmental sciences, during the last 30 years. However, our laws and policies are still based on outmoded concepts. In addition to a dependency on outmoded concepts, environmental laws suffer from a dependency on what I will refer to as arguments from plausibility rather than arguments based on scientific information. Finally, the process by which environmental laws and policies are developed suffer from a lack of communication between government and citizens and between experts and citizens. Therefore, this article focuses not only on the content of the laws and policy, but also the process by which we arrive at law and policy.

The first two problems, relying on outmoded concepts and basing arguments on plausibility, derive from a paradigm about Nature and the relationship between human beings and Nature that is so pervasive and deep within our culture that we operate from it without knowing we are doing so. The way that we operate from unrecognized and deep-seeded assumptions is illustrated by a story concerning the town of Croton-on-Hudson where I went to high school. This town is about 30 miles north of New York City and on one of the main railway routes from that city. While living in Croton, my family developed a friendship with Harry Nelson, a railway conductor with a good sense of humor, widely known to commuters for his stand-up comic monologues on the trips to and from the city. After work, Harry would often tell us humorous stories about passengers on the trains.

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There are two main railway lines that lead from Grand Central Station in New York City. One goes straight north to Croton-on-Hudson and then north and west to Albany, Buffalo, Chicago. The other goes east through Stamford, Connecticut and onto Boston. Harry told us of an incident that occurred while he was a conductor on a rush hour commuter train. The train was just leaving Grand Central Station when a businessman came running down the platform lugging a briefcase and, just like in the movies, jumped on the train after it had started moving getting aboard just in time. He was out of breath, so it took him a while to settle down. Meanwhile, the train sped up and began its way through the long tunnel that led out of the station. Once the businessman regained his composure, he called the conductor over and said "Is this the 5:02 to Stamford?" Meaning: Is this the train that goes east? Harry said "No, it's the 5:05 to Croton," which of course was the northward bound train. The businessman replied "Oh heck, What's three minutes?"

This businessman was so focused on whether he was going to make his train that he totally missed the object of his concern, where he was going, not when. This kind of mistake, operating from an unrecognized and incorrect assumption, is typical of the way we make choices about the environment. We have the wrong paradigm which leads us to focus on the wrong factors. What is needed today is a paradigm shift.

I. THE MYTH OF THE BALANCE OF NATURE

There has been a revolution in environmental sciences. At the heart of this revolution is a shift from the old idea of the constancy of Nature which is part of the ancient myth of the Balance of Nature. Briefly stated, the Balance of Nature myth has three basic features: First, Nature, undisturbed by human influences, achieves a permanency of form and structure that persists indefinitely. Second, this permanent condition is the best condition for Nature: best for other creatures, best for the environment, and best for humans. Third, when disturbed from this perfect state, Nature is capable of returning to it.[1] The idea of the Balance of Nature is deeply rooted in our history, civilization, and religions. It is a lot deeper than whether the train is going to Stamford or Croton.

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1. The discussion of the Balance of Nature is based on my book, DANIEL B. BOTKIN, DISCORDANT HARMONIES: A NEW ECOLOGY FOR THE 21ST CENTURY (1990).

Unfortunately, the Balance of Nature myth is not true. During the past 30 years, this has been demonstrated as part of the revolution in environmental sciences. One of the central findings of this scientific revolution is that Nature is characterized by change, not constancy. The environment has always changed, and species have adapted to those changes. If we are to conserve and manage our living resources, then we must understand the naturalness of change, and this requires that we move away from the ancient and pervading myth of the Balance of Nature.

A. *Example: The Kirtland's Warbler*

One of the classic cases that proves this point is the Kirtland's warbler, a small bird which nests only in Michigan, and there only in some specific kinds of habitats. Incidentally, it is smart enough to migrate to the Caribbean and winter in the Bahamas.[2] Unlike the snail darter or Furbish lousewort (species whose possible endangered statuses were used as surrogates to try to protect something else, as in the case of the snail darter, to attempt to prevent the construction of a dam), the Kirtland's warbler was of direct interest itself to the people of Michigan.[3] It was not a surrogate for other things. As testimony to that, it had been proposed as the state bird of Michigan, and it was the first song bird ever subject to a complete census by ornithologists.[4] Once the censuses began, ornithologists were shocked to discover that the population of the Kirtland's warbler had dropped in half in about five years. They began to puzzle about why this was happening.

In the 1920's Norman Wood suggested that forest fire was the worst enemy of the Kirtland's warbler because the birds nest in Jack Pine forests which burn readily.[5] But in the late 1960's, realizing that the population was dropping, ornithologists rapidly came to a very different conclusion. They realized that Jack Pine, like many pines, is a species which has evolved with and adapted to fire and is therefore dependent on fire.[6] Jack Pine has cones called "serotinus."

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2. *See* Daniel B. Botkin et al., *Kirtland's Warbler Habitats: A Possible Early Indicator of Climatic Warming*, 56 BIOLOGICAL CONSERVATION 63 (1991); BOTKIN, *supra* note 1, at 68-70, 195-196; H. MAYFIELD, THE KIRTLAND'S WARBLER 1 (1969).

3. MAYFIELD, *supra* note 2, at vii.

4. *Id.* at 1-2.

5. *Id.* at 23.

6. *Id.* at 27-28.

Serotinus cones have glue on their scales which free up only after they are heated by fire,[7] or, as a graduate student told me who was studying Jack Pine, if you leave the cones in the back seat of your car on a hot summer's day where the temperature can get up to 120 degrees.

Therefore, in the forest, Jack Pine cannot release seeds and the seeds cannot germinate without fire.[8] In addition, the trees can grow only in bright light.[9] So, even if Jack Pine trees were planted in an already existing forest, the Jake Pine would not survive because they cannot grow in the shade of other trees.[10] As a result of these characteristics, Jack Pine only comes into areas that have recently burned and there they form what foresters call "even-aged" stands — a group of trees that germinated at the same time and grow up as a group. When you visit a Jack Pine forest, you will not see small Jack Pine growing under larger trees.

In the areas of Michigan where the Kirtland's warbler nested, Jack Pine was disappearing because of the twentieth century practice of fire suppression.[11] Fires had been suppressed because fires were seen as a disturbance, and such disturbances went against the Balance of Nature. A concomitant to this myth is that old-age forests are good and necessary. So the Jack Pine as a habitat was disappearing.

Realizing the need of the warbler for fire-regenerated forests, the Audubon Society, the United States Fish and Wild Life Service, and the Department of Natural Resources of the state of Michigan got together. The state set aside approximately 30,000 acres and a plan was devised whereby every year a certain patch of land is burned to provide renewed habitats for the species.[12] It is interesting to note that, in contrast to the earlier AUDUBON article, an AUDUBON article published in the late 1960s about the Kirtland's warbler was titled "The Bird Worth a Forest Fire."[13] So in about 30 years learning had occurred, and a new understanding was reached that this bird required change. Now there is management that takes the need for

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7. *Id.* at 23.
8. BOTKIN, *supra* note 1, at 65.
9. *Id.*
10. *Id.*
11. MAYFIELD, *supra* note 2, at 27-28.
12. J. BYELICH, ET AL., U.S. DEP'T OF INTERIOR, KIRTLAND'S WARBLER RECOVERY PLAN 1 (1985).
13. Les Line, *The Bird Worth a Forest Fire*, 66 AUDUBON 371 (1964).

such change into account. This is a positive example of the necessary paradigm shift.

B. *Example: The Hutchinson Forest*

Another example which demonstrates the dominance of the Balance of Nature myth is the story of Hutchinson Memorial Forest, a nature preserve near to and managed by Rutgers University. I was the caretaker of the forest when I was a graduate student at Rutgers. Originally, this forest and surrounding lands had been purchased in 1701 by a Dutch family known as the Mettlers.[14] They maintained a piece of their holding as woodlot and never harvested it. As a result, by the 1950s it was the only never-cut Oak-Hickory forest in New Jersey. My professor, Murray Buell, who was a very good naturalist and one of the most important plant ecologists of the 1950s and 1960s, studied Hutchinson Forest and decided that he would do what he could to help conserve this forest. He managed to persuade the Carpenters Union and Sinclair Oil to provide funds so that it could be maintained as a nature preserve.

The establishment of the Hutchinson Memorial Forest Nature Preserve was a media event. There was a major article in AUDUBON about it and there was a major advertising campaign by Sinclair oil featuring the forest. Life magazine ran an article showing a drawing of the forest that looked right out of a Walt Disney movie with all the forest creatures happily living together. All the popular articles and advertisements emphasized the idea that here, in Hutchinson Forest, was a natural ecosystem that had taken thousands of years to develop and, if left free from human disturbances, it would persist indefinitely in the beautiful state imagined by Life Magazine.[15] This was an image of the Balance of Nature with every creature in its place and a place for every creature. A central idea was that to maintain the forest, one had to leave it alone. It was supposed to stay as Oak and Hickory with magnificent huge trees. As caretaker, I walked around the forest often, usually every day, and found that there were few Oak seedlings. Instead, most seedlings and saplings were Sugar Maple with some seedling of Norway Maple (an introduced species).

There was another difference between modern Hutchinson Forest and the ancient forests as seen by early explorers and botanists. For

14. M. F. Buell et al., *Fire in the History of Mettler's Woods*, 81 TORREYA 253 (1954).
15. L. Barnett, *The Woods Of Home*, LIFE, Nov. 8, 1954, at 78.

example, in 1749 and 1750 a Swedish botanist, Peter Kalm, was sent by Linnaeus to collect plants in North America. Kalm traveled from Philadelphia to Montreal. He kept a journal and he passed right through the area where Hutchinson Forest stands.[16] He wrote that this area was filled with large trees so widely spaced that he could easily drive a horse and carriage through the forest. So, at that time the area was a picture book idea of an old-growth virgin forest. Today, and when I was a caretaker, the forest had some old trees, but it was primarily a dense thicket of small stems of shrubs and saplings, very hard to walk through, and, as I mentioned before, with the young trees primarily Maple, not Oak.

So Nature was not playing fair by not staying the way it was supposed to stay. It was not remaining a forest of huge, old Oaks and Hickories. It was not the open forest of huge trees seen by Peter Kalm. That is one of the problems with studying natural ecological systems, Nature does not play fair in the sense that it does not do what we expect it to do, and therefore to want it to do, according to our myths and beliefs.

What was going on here? Why was the forest not remaining in a constant condition and in the specific constant condition people had imagined it should have been in? The answer was discovered through a study of tree rings. As is well known, trees in temperate and northern forests produce annual growth rings. When fire burns through the bark of a tree, it leaves a fire scar, much like we get a scar when we suffer from a burn. But then the tree rings grow over the scar. So if you have cut through a tree stump, you can count the number of rings between fires and therefore the number of years between fires. There was a hurricane in the 1950's, and some of the big trees in Hutchinson Forest fell over. These were cut through and studied to determine how often there had been fires. These trees showed that there had been fires on the average of every ten years until 1701, and then there had been no fires since that time.[17]

The fires that were common before European settlement were primarily lit by the Indians.[18] The early European explorers, such as Henry Hudson, reported seeing many fires and attributed them to the

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16. P. KALM, TRAVELS IN NORTH AMERICA: THE AMERICA OF 1750 (A. B. Benson trans., 1963).

17. Buell et al., *supra* note 14.

18. G. M. Day, *The Indian as an Ecological Factor in the Northeastern Forest*, 34 ECOLOGY 329 (1953). Day suggests that fires were common and purposely set to clear the forest in order to make traveling and hunting easier and to drive game. *Id.* at 334.

Indians.[19] There were many different reasons given as to why the Indians lit fires or let them burn once they were started, including: to drive game and to make travel easier. Whatever the reason, these fires were predominately Indian lit. It turns out that Oak and Hickory are more resistant to fire than Sugar Maple. Therefore, the reason Hutchinson Forest was predominately an Oak and Hickory forest was because the Native Americans burned it. It was also an open forest because of the fire. If you do not burn this kind of forest, it becomes a dense thicket dominated by Sugar Maple. So with the suppression of fire, Hutchinson Memorial Forest was becoming a forest that nobody had predicted, and I do not think anybody really wanted. It was becoming a scientific experiment not the conservation of old-growth as originally intended.

What this suggests is that often what we really admire and appreciate about Nature, and think of as natural, has been heavily influenced by human beings. But the old Balance of Nature paradigm assumes that Nature remains in a single, constant condition which is the most desirable. This implies that people should leave Nature alone if we want Nature to attain its most desirable condition. Nature is perfect without human influence. Therefore, we have no place within Nature.

As I stated earlier, the new findings in ecology show that natural ecological systems are dynamic — always changing — and, as illustrated by Hutchinson Memorial Forest, sometimes the changes that are desirable are those induced through human action. In these ways, a nature preserve is different from a jar of strawberry preserves. However, we have acted as if the two were much the same: as with strawberry preserves, a nature preserve merely needed to be set aside and left alone.

Hutchinson Forest is not unique. The more that we study the history of natural areas, the more that we find that pre-industrial societies have altered the environment, often in ways that we like and that we think of as natural. As a result, we have to rethink how people and civilization fit with Nature.

II. IMPLICATIONS OF THE PARADIGM SHIFT

What are the implications of these changes in our understanding of natural ecological systems and the relationship between people and

19. *Id.*

Nature for laws and policy? I will illustrate some implications by way of another example. I was asked by the State of Oregon to direct a study about salmon and their habitat.[20] The central questions to be answered were: (1) what was the relative effect of forest practices on salmon; and (2) what could be done to better improve the conservation and management of salmon? We were asked to study Western Oregon south of Columbia River to the Klammath River in California, an area that includes 26 rivers that reach the Pacific Ocean.

There are five important species of salmonids in this area: chum, coho, chinook, steelhead trout and cutthroat trout. They spawn, hatch and rear in the streams and rivers. The young fish stay in fresh water for about a year — the time varies with the species. During this early phase of their lives, the salmon are subject to short term environmental variations such as annual variations of water flow and changes in the seasons which affect the vegetation along the streams. They are also subject to gradual, long-term changes in the condition of the forest. When the salmon swim out to the ocean where they typically remain for two to six years, depending on the species, they are affected by other kinds of environmental variations. These variations include changes in the ocean currents.

Moreover, salmon are fish of northern waters, so over centuries they have had to adapt to existing in rivers which freeze in the winter yet thaw in the summer, allowing the fish to spawn. In addition, in the Pacific Northwest, rivers and streams are subjected to volcanic eruptions, mud slides, forest fires and other environmental variations that affect the stream habitats over significant periods of time.

The standard story about salmon is that they always return to the stream where they were spawned. But this is not quite the case. About fifteen percent of the adults return to a different stream from the one in which they were spawned. Given the variations in the environment, the ability to find new streams for spawning is essential to the survival of the species. The ability of individual salmon to adapt is essential to the existence of the species because it allows salmon to adapt to very slow environmental changes.

There is a common set of beliefs about salmon in Oregon that needs to be addressed. The important beliefs for our purposes are:

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20. *See* Daniel B. Botkin et al., Center for the Study of the Environment, Status and Future of Anadromous Fish of Western Oregon and Northern California: Findings and Options (1995) (on file with author) (detailed references to specific case studies can be found in this report).

(1) prior to European settlement, there was a superabundance of salmon; (2) the number was constant from year to year; (3) old-growth forests covered the entire area; (4) the great abundance of salmon was due to the existence of the continuous cover of old-growth forests. Here, among the common beliefs about salmon, we find a reassertion of the myth of the Balance of Nature.

One would think the state of Oregon would have a lot of information about this subject since they were paying for the project, but in actuality the state did not. One would also think that, given the intense interest in salmon, the data that was available would have been thoroughly analyzed. It had not been. We found an ironic situation: little of the data required to answer the question existed, but of the data that did exist, little had been examined. This resulted in an interesting situation. It was difficult to find data, but once some were obtained, even the simplest analyses yielded useful results. For example, we asked for all the data concerning the number of returning adult salmon each year for each of the 26 rivers we were asked to study. We found that salmon were counted on only two of those rivers in a statistically valid way: the Rogue and the Umpqua Rivers.

Upon commencing the study, it was discovered that the number of adult salmon returning to spawn varied tremendously. Variation, rather than constancy, was the rule. But how have the salmon been managed? It is generally assumed that, without human harvest, the number of returning salmon would be the same year after year, unaffected by changes in the environment. This assumption is set forth mathematically in standard fisheries harvest models. However, major fisheries relying on such harvest models have failed to maintain their fish levels. These failures call into question the validity of the assumption that without human intervention the salmon population would remain constant year after year.

Therefore, while conducting the study, we decided to avoid assumptions accepted prior to the examination of the facts. We also searched for available data, analyzed that data, and let new generalizations emerge from the data analysis. I organized a small group of six scientists, including myself.[21] I selected panel members who had

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21. The members were: Dr. Thomas Dunne, geomorphologist; Dr. Kenneth Cummins, stream ecologist; Dr. Henry Regier, fisheries biologist; Dr. Mathew Sobel, mathematical economist; and Dr. Lee Talbot, wildlife ecologist. The ideas presented here are the result of the work of the entire panel, as well as of subcontractors, and I am indebted to them for their work

no political or ecological bias about the outcome of the study and who were known for their excellence in their field and their willingness to take an innovative, fresh approach. Each member represented a different field of expertise.

Attributes of our approach were openness and democracy. We listened to public, national and local interest groups, and both non-governmental and governmental organizations. We also held open meetings because we wanted to learn from the public and to relay information to the public as we uncovered it.

Our study was supplemented by the work of Jim Welter, a local fisherman. He went to the United States Geological Survey and the Oregon Department of Fish and Wildlife to obtain water flow data for the Rogue and Umpqua Rivers where salmon returns had been counted. He plotted the data from both sources. The resulting graphs suggested that there was a strong relationship between water flow in the year fish were hatched and the number of adults returning three and four years later. We performed statistical analysis on the data Jim Welter collected and discovered that water flow accounted for a large percentage in the variation in fish returns during the past 20 years on the Rogue River.

What we had done was to turn the standard beliefs upside down. Instead of avoiding environmental variation and assuming that it did not exist, we used environmental variation as the basis for prediction and therefore as a basis for policy. Using this approach, we developed a new tool that allowed an estimate to be made three years in advance about whether a year was likely to be a good one for salmon harvests. Not only was the accuracy of prediction increased, but a much longer time was now available in which the harvest level could be set. This has great practical advantages. Under the old methods, the allowable harvest is set during the present year sometimes close to the harvest time which allowed fishermen little time to plan and little flexibility.

This example shows that we are not helpless to make forecasts and set policies for a dynamic ecosystem; just the opposite. By learning to understand the dynamic of these systems, we can make better forecasts and make better laws and policies than we ever could previously. It is not clear if the people in management will actually use these new ideas, because they may still be locked in the old way

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on this project. While the work is the result of the entire panel, specific interpretations of that work as presented here are mine.

of thinking. Policy-makers, and we as scientists, need to move away from the old beliefs about nature.

It may seem quite strange that there is such lack of interest in using data. Part of the reason for this, I believe, can be traced back to the myth of the Balance of Nature. As I have tried to make clear, this myth involves the idea that Nature knows best and will always move itself to a perfect, constant state. If this were true, then you would not have to know anything about Nature in order to manage it, data would have no importance. Nature would take care of itself; knowledge would not be important. This produces a strange irony in the late twentieth century "information age." The failure to use the data about adult fish returns, or to seek to obtain such data in a statistically valid way, is typical. Whenever I have been asked to examine an environmental problem, I have found that key information is lacking. Let me give you several more examples.

When we asked the State of Oregon for a table about the water flow of the 26 rivers, they did not have it. We were asked to examine the relative effects of forest practices on salmon, so we asked the state for a map of present forest conditions. They did not have one but did produce one from remote sensing data for us. We asked for records of logging permits, with information about the location, size, and method used. We were told that such information was not recorded. Permits for logging were given by each county, and these did not record the location, size of the cut, nor methods, and the permitting information that was obtained was kept only for five years.

Another example illustrating the resistance to obtaining information and the cultural momentum of beliefs about Nature concerns Californian sea lions. In 1899 the Fish Commissioner of California decided to shoot 10,000 sea lions because they were taking too many salmon. A man named Merriam, working in federal government in Washington, went to California to study the situation.[22] In a report he wrote in 1901 in SCIENCE, he said that he "took the trouble to examine the stomach contents of the sea lions."[23] He found no salmon; only squid and octopus.[24] He cited another scientist who went out on boats with bounty hunters. A hunter would pick out a sea lion and say that one had been eating salmon, and then he would shoot it. The scientist would take the carcass to the shore, cut it

22. C.H. Merriam, *Food of Sea Lions*, 13 SCIENCE 777 (1901).
23. *Id.* at 777.
24. *Id.* at 778.

open, and examine the stomach contents. He never found that the sea lion had actually eaten a salmon.[25]

Since then, the debate over sea lions has continued for 100 years. The effect of sea lions and harbor seals on salmon is one of the most tractable scientific problems concerning the species. With careful consideration of measurement design, a two or three-year study could examine the stomach contents of these mammals to provide an estimate of their year-round take of salmon. Studies that have been conducted since 1901 have involved single or sporadic measurements lacking statistical design, or have not included all the measurements necessary to make a complete estimate.[26] Observations make clear that sea lions and harbor seals can be a local problem, especially where fish ladders make it easy to catch the salmon.[27] Our study concluded that there has yet to be an adequate research project about the effects of marine mammals on salmon, but available data suggest that sea lions and harbor seals are a minor factor in the overall death rate of salmon. This is an illustration of our failure to seek information we need.

Henry David Thoreau recognized the same problem in the first half of the nineteenth century. In his book, CAPE COD, Thoreau wrote about harvest of black fish (a small whale).[28] Thoreau was interested in the economic value of this harvest to the fishermen of Cape Cod. After his trip to Cape Cod, he tried to find information about black fish that could be useful to the fisherman. He found that the state did not have information and complained that the state was derelict in its duty to provide fundamental, useful information about these animals.[29] This tells us that the problem is persistent in our society.

Not only do we tend to formulate policy from myths about Nature, we also formulate policy based on what appears plausible, whether or not there are facts to support it. As an example from

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25. *Id.* at 778-779.

26. *See, e.g.*, M.S. Lowry et al., *Food habits of California sea lions Zalophu californianu at San Clemente Island, California, 1981-86*, 88 FISHERIES BULL. 509 (1991). *See also* M.S. Lowry, *Seasonal and annual variability in the diet of California sea lions Zalophu californianu at San Nicolas Island, California, 1981-86*, 89 FISHERIES BULL. 331 (1991); R.J. Jameson & K. W. Kenyon, *Prey of sea lions in the Rogue River*, 58 OREGON. J. MAMMOLOGY 672 (1977).

27. M.A. FRAKER, MARINE MAMMAL COMM'N, CALIFORNIA SEA LIONS AND STEELHEAD TROUT AT THE CHITTENDEN LOCKS, SEATTLE (1994).

28. HENRY DAVID THOREAU, CAPE COD 111-115 (Penguin Books 1988) (1864).

29. *Id.* at 115.

Oregon, in the 1940's people watching salmon swimming up stream noticed that in drought years the fish had trouble going over logs that had fallen across the streams. Many of these logs were large and, because they were submerged in water, decayed slowly. The logs had considerable value, especially during World War II. So a plan was devised to harvest all these logs on many streams throughout the state. The negative effect of the log debris in the streams on salmon seemed plausible. Both salmon and the war effort could be helped at the same time. No one conducted a test study to determine if the removal was actually beneficial. The result was a disaster for salmon. Those logs were fundamental to the structure of salmon breeding habitat. Thus by removing the logs, the salmon habitat was destroyed. To correct for this past mistake, the Oregon Department of Fish and Wildlife is spending over $30,000 a mile to put logs back into the streams and anchor them. But are they doing tests to see if this works? No. I went out with some of the Department's staff and asked whether they counted the returning fish before they started putting logs back in the streams. No. I asked if they were counting the fish now. No. Were they doing any comparative studies? No. So the action had changed, but the approach was the same: do what seems plausible.

CONCLUSION

I have discussed some of the implications of new ideas in ecology upon environmental laws and policies. There has been a revolution in ecology, in fact in all environmental sciences, during the last 30 years. However, our laws and policies are still based on old, now outmoded concepts, especially on the myth of the Balance of Nature. That myth not only tells us that Nature, undisturbed by human actions, will remain constant, but also that this constant state is the most desirable. Thus, Nature knows best. A corollary of this belief is that to manage our natural resources we do not need any information, we need only to leave Nature alone and it find will the correct state. Laws and policies based on this belief have dominated natural resource management in the twentieth century. As a result, there has been little emphasis on data. In addition to a dependency on outmoded concepts, environmental laws suffer from a dependency on what I have referred to as arguments from plausibility rather than arguments based on scientific information.

There are several characteristics to an approach that can help us become free of these old ideas: avoid hypotheses based on myths; instead, search for and examine available data. Let generalizations emerge from an examination of the data. Create an open process, involving the public. As in the example of Jim Welter, sometimes experienced people without formal training will be free of the standard management paradigms, and have fresh insights. In a democracy, such connection to the people is not only useful but necessary.

We are living in a time of major transition in our beliefs about Nature. This transition affects many aspects of our lives. Our beliefs about Nature are deep-seated within our culture. As a result, change comes slowly. As we prepare for the twenty-first century, we need to accept the variation in Nature so that we can move toward a constructive, active role for people in Nature, and become able to formulate policies, based on Nature's variations, that work.