Environmental Review

A Monthly Newsletter of Environmental Science and Policy

Volume Nine Number Seven **July 2002**

Aldo Leopold and the Huron Mountain Club

Introduction:

Aldo Leopold (1887-1948) is best known as the author of *A Sand County Almanac* and as one of the founders of the Wilderness Society. He was part of the first generation of professionally trained foresters to apply the new science of ecology to forestry, and he became an eloquent advocate for conservation of America's wildlands. In 1938 the Huron Mountain Club asked him to develop a plan to manage their 15,000-acre holdings in upper Michigan, one of the last uncut stands of forest in the upper Midwest. His plan, which the Club adopted, reflected his mature thinking about how to balance human use of forests with their preservation. If Leopold's ideas had been more widely applied in America during the economic expansion that took place after World War II, it is safe to say that many of the controversies regarding endangered species and forest harvesting would have been avoided. We spoke with Curt Meine about the development of Leopold's ideas and their relevance to our present difficulties.

ER: Dr. Meine, what is your training?

CM: My graduate training was in an interdisciplinary program which combined wildlife ecology, plant ecology, history, journalism and geography at the University of Wisconsin's Institute for Environmental Studies. For my dissertation I wrote the biography, *Aldo Leopold: His Life and Work*, the first full-length biography of Leopold[1]. After that I went to work with the National Academy of Sciences in Washington D.C. working on reports on biodiversity conservation, sustainable agriculture, and international development. Then I returned to Wisconsin and the International Crane Foundation where I work with the World Conservation Union (IUCN) in the Crane Specialist Group.

Over the last decade I've also done a fair amount of conservation work in Eastern Europe and Southeast Asia through ICF and other organizations. I'm also Director of Conservation Programs with the Wisconsin Academy of Sciences, Arts, and Letters, one of those venerable, interdisciplinary institutions chartered in the late 1800s. We're working to revive the Wisconsin Academy's tradition of work in the public interest in the natural sciences and conservation policy. I'm also on the board of the Society for Conservation Biology and have been active in SCB for many years.

ER: Where is Leopold in the food chain of academic philosophers like Carl Popper, or do they even recognize him in the academic philosophical world?

CM: Those who are formally trained in academic philosophy and who don't have a gut-level interest in environmental affairs probably won't know Leopold, and would probably pay him little heed if they did. Leopold does not come out of that formal academic philosophical tradition. On the other hand, if you talk with those who have come to philosophy through their interest in the current state and future of the world, you'll find that Leopold is a touchstone for many. And he's a beginning point for those who have created and carried forward the discipline of environmental ethics.

Leopold appeals to different thinkers in different ways. For example, the person who coined the term bioethics was the late Van Renssalaer Potter, a prominent oncologist based at the University of Wisconsin-Madison. In his writings he noted how Leopold's work helped him to move across the biological hierarchies and to under-

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stand the importance of systems thinking in connecting human and ecosystem health. In the early 1970s, when he first began to use the term bioethics, he hoped that it would apply across the levels of biological organization and help us to understand the connections between the health of cells, organisms, populations, and ecosystems.

Leopold did not think of himself as a philosopher. In fact, he was rather reticent in his writing about what he called the philosophical questions. He recognized that these questions required greater attention from those with the proper expertise. He wrote his essay *The Land Ethic* partly out of a sense of frustration. When Leopold first put down on paper some of what we might think of as small p philosophical thoughts, in the 1920s and early 1930s, he did so because no one else was doing so. I don't know if I could can name a person in the world of formal philosophy or theology at the time with a practical understanding of the issues facing, for example, foresters, wildlife managers, or soil conservationists.

ER: Strict utilitarianism seemed to be the only politically viable way to save anything when he was starting out.

CM: An implicit, and often explicit utilitarian philosophy guided many of the early conservation leaders. Leopold's work, and others working in the 1920s and 1930s, began to transform the utilitarian assumptions of the early conservation movement. The more romantic tradition, as exemplified by John Muir was inadequate for biodiversity conservation, retaining the functioning of ecosystems, and more integrated approaches to whole landscapes. Leopold was a transition figure trying to synthesize new scientific concepts while providing stronger philosophical foundation for conservationists.

I've always thought that Leopold's sense of his contribution to philosophy was, Well, if no one else is going to do it, I'll give it my best shot and then let them pick it apart. And that's what happened after the publication of *A Sand County Almanac*. Especially since the 1980s, environmental ethics has gained an academic foothold and *The Land Ethic* has become a cornerstone for discussions in the field. Philosophers and theologians, as well as economists, historians, educators, political scientists have gone back and read Leopold and have provided a much deeper understanding of the antecedents to his thinking, how he drew on different sources in literature, science, history, ethics.

Leopold's plan is an early example of an alternative to the way we have tended to manage forests for the past sixty years.

ER: Leopold started out as a Forest Service ranger who bought into the utilitarian program. At the end of his life, even though he had moved on, he was still using utilitarian arguments for conservation. Why?

CM: Leopold's conservation philosophy always comprised elements of a utilitarian approach as well as an aesthetic or preservation-oriented approach. Historians have focused on that dichotomy in understanding the development of environmental thought and policy. Leopold is fascinating because both elements were present throughout his life, and he struggled with the tensions and connections between these viewpoints.

Conservation never has been reducible to a simple, black-and-white, utilitarian vs. aesthetic stereotype. The classic manner in which historians have approached this has been to build off the schism between Gifford Pinchot and John Muir during the height of the Progressive Era conservation movement. That schism set the tone for this reading of environmental history. Yet, when one closely examines even John Muir and Gifford Pinchot, their lives and their work, one sees that this polarity gets all mixed up.

Leopold comes along as part of the next generation of conservationists, confronting new and different conservation dilemmas, with more sophisticated scientific resources to draw on. Leopold in his writing and in his fieldwork tried to move conservation beyond the simple schisms, recognizing the reality of human resource use as well as the reality of the human aesthetic and spiritual response to the world. Both are fundamental. Neither can be ignored.

How do you deal with this tension if you're a conscientious working conservationist? That's the main story line of Leopold's life. In my own view he comes to, if not a resolution of the conflict, at least an accommodation of the different needs in a practical way.

The Environmental Review (ISSN 1080-644X) is published the first business day of each month. Address correspondence to 6920 Roosevelt Way N.E. PMB 307, Seattle, WA. 98115. Douglas P. Taylor, Publisher. Domestic subscriptions (12 issues) $25.00 in U.S. currency. For Canada and Mexico add $10.00. All other foreign add $21.00. Teachers, students, and seniors in the U.S. may subscribe for $15.00 per year. Email subscription is free. Change of address: allow 4 weeks, giving old and new address. email dtaylor@igc.apc.org - Web site URL = http://www.igc.apc.org/envreview

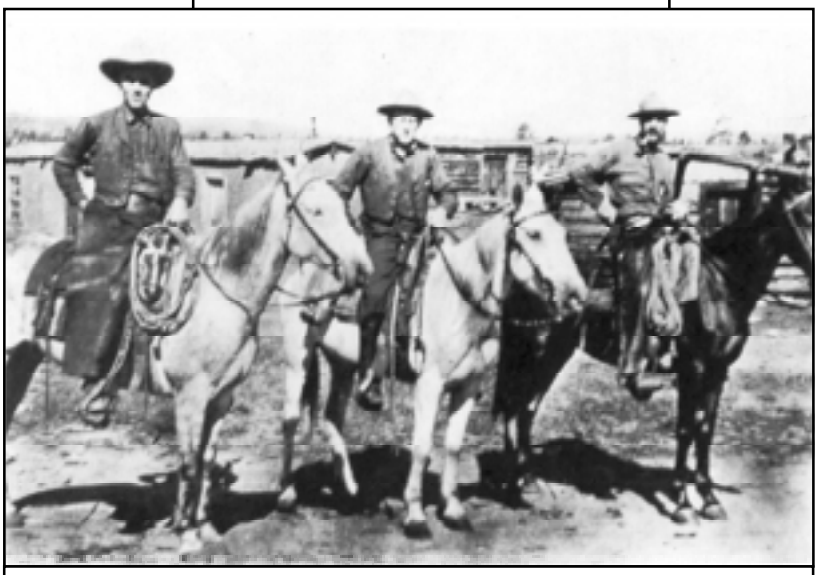
The earlier approaches to conservation were in a sense pre-ecological. The science of ecology was still emerging and did not inform those early competing schools of conservation thinking as they were taking shape. It was only in the 1930s that we find the first influx and application of concepts from scientific ecology in conservation. That is where Leopold finds himself. He recognizes that this new science, this new way of understanding the world alters the way we must think about our capacity to manage natural systems. It demands changes in our thinking about the role of people within natural systems. This was Leopold's great contribution to the 20th-century conservation movement.

ER:

CM: He has most of these pieces together in his own thinking by the end of the 1930s, but World War II and its aftermath gives it an added layer of depth. When you read Leopold's best-known work, *A Sand County Almanac*, you get the postwar Leopold, especially in the essay *The Land Ethic*. The book is a product of the postwar world, especially in the sense that the war changes the way we think about science and its role in human affairs.

The ending of the war, in particular, was a cautionary moment for those who cared about natural places and processes. Even though parts of *Sand County Almanac* predate the war, Leopold's final composition of the book drives home the lesson that without a sense of community and morality to guide the application of knowledge, we place ourselves and all the things we care about at risk.

All of this is transforming Leopold and the conservation movement in general through the 1930s and 1940s. Leopold was not alone. He was part of a generation, a community of conservationists facing difficult realities in those years: deforestation, depletion of wildlife, the Dust Bowl, the Depression, World War II. But being gifted in his ability to write, and attentive to the social dimensions of the conservation movement, he was able to clarify these concerns for his colleagues.



Aldo Leopold (left) started his career as a Forest Service ranger in the Southwest.

ER: How did this work out in his proposal for the Huron Mountain Club?

CM: This relates to Leopold's work at the Huron Mountain Club in that his report to the Huron Mountain Club was one of many reflections of the rapid changes in his way of thinking in the late 1930s. If a more specialized forester had been asked to prepare the plan for the Club, they would more likely have done a different job than Leopold did.

ER: Even now.

CM: Or perhaps even now. But we have learned some things, and forestry is no longer the more monolithic field that it was in the decades following World War II. Forestry in the pre-World War II years did have a complexity to it that was lost in the postwar years. So to return to Leopold's views in the 1930s is to get a snapshot of a time just before the war changed the conservation professions and the cultures of these disciplines.

ER: Before the Second World War the Forest Service was an elite outfit like the Park Service; after the war it became a lackey for the timber industry.

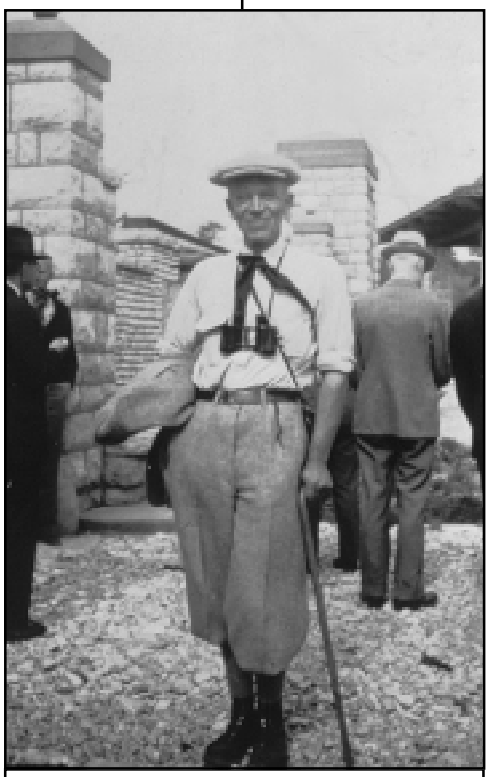
CM: I tend not to make such sweeping generalizations.

ER: Well, the Forest Service changed and it wasn't good.

CM: No, I agree. I know exactly what you mean. What I mean by that is to say that all professions have tensions within them. That's a healthy thing. That's part of what makes a profession grow and change. There is certainly a shift in priorities, and especially in professional training, in the aftermath

of the Second World War.

Leopold's roots went back to the origins of forestry in the U.S. He belonged to that first generation of trained foresters to come out of Yale. He had all the credentials of a professionally trained forester, going into the Forest Service to apply his newly acquired skills. But he also challenged the profession from within to grow and become something bigger than it was, to recognize and meet human needs beyond board feet. He couldn't have done it if he didn't have those credentials, if he didn't have acceptance within his profession. They couldn't dismiss Leopold as a crazy, wild-eyed wilderness fanatic, even though he was one of most active and vocal advocates for wildland protection in the Forest Service.



Leopold in Germany in 1935.

Leopold was a reformer, but a highly responsible one. He understood that as you gain knowledge, you must change your views on how to apply it. And you need to explore the cultural context of conservation or else you're serving only your profession, not society as a whole, much less living as a responsible human being on Earth. So you have spheres of responsibility. You can take refuge within your professional circle, or you can be one of those who tries to be a moderator between the profession and the larger world.

Leopold was one of the founders of wildlife ecology and management as a separate discipline in the 1930s, and he challenged his colleagues in that field in the same way. When he was president of the Wildlife Society in 1940 he delivered a hard-hitting presidential address, essentially saying, We can be the best wildlife technicians in the world, but if we are not serving these larger goals then we are failing.

ER: He seemed to be good at a lot of things.

CM: Most people today, if they know of Leopold, know of him mainly as the author of the *Sand County Almanac*, and sometimes even more narrowly: he's the person who provided philosophical definition to environmentalism through his idea of a land ethic. That is all accurate and important and justified, but it's also incomplete.

As time has gone on, I hope that the scholars working on Leopold, Susan Flader and Baird Callicott and others, have helped to fill out our view of Leopold. This, I think, is what we have all tried to show: that the author of *Sand County Almanac* is the end product of broad, diverse experience, professionally and personally, and that *Sand County Almanac* is best understood as the culmination of his work.

As important as the Almanac was, there are other lessons to be gained from looking at all that Leopold did before then as a pioneer in many different fields of resource management. He had expertise in wildlife, forestry, soil and water conservation, range management, agriculture, recreation, education, and economics. Choose your aspect of conservation and Leopold was there. He was working at a time before these different fields became so specialized that you couldn't hop the fence and work in others. So when you look back on Leopold and how he grew through the 1920s and 1930s, you find him jumping around and connecting fields with wonderful abandon. He was an instinctive synthesizer and integrator.

So, for example, though trained as a forester and perfectly conversant in the techniques of silviculture and timber harvest planning and board feet calculations and so forth, he was also aware of the recreational values of forestlands, the wildlife component of the forest ecosystem, the value of wildlands, and the impacts of human land use on ecological processes.

He would draw lessons from what he was working on and apply those lessons in the next task that he took on. As he began to see the need for greater focus on wildlife and helped to build that profession, he didn't walk away from forestry; rather he recognized that if you're working in a forest ecosystem you need to be thinking about all its components: the forest trees, other plants and animals, soils, water, and people simultaneously. That's conservation.

ER: He seemed to hit his stride in the 1930s.

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CM: As forestry was developing through the twenties and thirties, Leopold is aware of all this but he's also charting new territory. The key period in this, as I've mentioned, is the mid to late 1930s. Through a series of field projects, personal experiences, and professional opportunities in those years, Leopold's own philosophy is gelling, and he's pulling the conceptual pieces together.

First was his purchase in 1935 of the land in Wisconsin that he describes in the *Sand County Almanac*. In 1935 he was a founding member of the Wilderness Society; and in that year he also took his only extended overseas trip, to Central Europe. In 1936 and 37 he took two trips to northern Mexico, his old stomping grounds, areas that he recognized were less affected by human activity than any other place that he had ever been. This gave him a deeper appreciation of wilderness and changed his psychological and ecological baseline for understanding the place of people in the natural world.

And all of this is prelude to this opportunity to work at the Huron Mountain Club. He'd already been making arguments about the need for more integrated approaches to managing land.

ER: Where is the Huron Mountain Club?

CM: The Huron Mountain Club includes about 15,000 acres on the shore of Lake Superior in Michigan. It still contains one of the best remaining stands of old-growth forest left in the upper Midwest. Leopold was hired by the Club to prepare a management plan for their lands, and visited there in 1938. It was an opportunity for him to apply the ideas that had been emerging, and it gave the Club a chance to tap into Leopold at the time when he was afire with new ideas. And he made the most of it.

Leopold produced a report that tried to integrate all the resource values of the site, rare species, game and other wildlife, recreation, research, wilderness, scenery, timber in a coherent conservation plan. He used emerging concepts such as management for rare species and the need to take a landscape-level approach, in a way that he had not even outlined in his own previous books or work on wildlife management. Leopold's plan for the property is a remarkable precedent for the way conservation biologists two generations later would look at the same piece of land and make similar recommendations.

Leopold's trip to Germany showed him that our approach to managing natural resources was bound to backfire...

ER: What did he recommend for the Club?

CM: Leopold's recommendation was that the club establish a core zone of land that would be preserved in its natural state; a buffer zone around that where human impacts would be less intensive; and around that an area where what we now call sustainable forestry could be practiced. Within this three-part zoning arrangement, Leopold recommended more specific steps for the integration of recreation, wildlife, scientific research, and forest management.

The Huron Mountain Club report is an early example of a land management plan intended to protect biodiversity and ecosystem processes while recognizing the human presence in the landscape. Leopold didn't use those terms, of course, because they weren't in usage back in 1938, but his plan is close to what we would look for from a modern conservation biologist.

To its credit the Club implemented much of Leopold's plan, and they have been able hold on to a real ecological treasure. It is a wonderful place for its members to explore and enjoy; it also serves as a valuable historical example, and the Club members have also helped to support research on their lands.

In the context of forestry Leopold's plan is an early example of an alternative to the way we have tended to manage forests for the past sixty years. What Leopold tried to do there, if one could imagine it being expanded across the continent, might have brought us closer to sustainability for forest

ecosystems. We might have avoided running into the spotted owl situation in the Northwest, or the red-cockaded woodpecker situation in the Southeast, or other conflicts that we could mention, if we had adopted such an approach generally. Leopold was well aware of the real and potential conflicts in forestry and he could see the writing on the wall to some degree, although he never could have anticipated the postwar lumber boom and how that was going to change forestry and forest landscapes. But if Leopold's approach in the Huron Mountain Club report had been more generally appreciated and applied, one can imagine that history would have unfolded in a different way.

ER: In Germany he saw the consequence of forestry as it was practiced, which was a highly managed, artificial landscape where they trucked in forage for the deer. That was as much an aesthetic as a practical issue with him.

CM: Right. Leopold connected the aesthetic impacts of intensive, artificial forestry with the biological, economic, and social impacts. I have a theory that Leopold's trip to Germany in 1935 was perhaps the single most important paradigm-shifting episode of any American conservationist of the 20th century. It showed Leopold that our approach to managing natural resources was bound to backfire if it did not reflect a systems perspective, if it didn't recognize interrelationships, if it didn't take into account the values of biological diversity, if it didn't see that a narrow economics-driven model of resource management was limited in its capacity to conserve all the components and functions of ecosystems and all that we value in them.

Leopold came back from Europe determined to keep American conservation from going down that road. A corollary to this was that conservation had to begin placing greater value on the wildness of the place, the diversity of its plants and animals, the degree of intact biological relationships within that landscape, and understanding of the dynamics of predator-prey-vegetation relationships. And it suggested that we must change how we count up the long-term economic costs and benefits of our resource management practices.

What dumbfounded Leopold and other American foresters who visited Germany in the 1930s, not just Germany, but other European forests, was that even measured by traditional timber values, those forests were suffering and were no longer as productive as they once were. Another two or three intensive rotations and they wouldn't be much good for anything.

There was also a long-standing alternative tradition in Europe of more naturalistic approaches to forest management. This in some ways went back to the origins of forestry, and you can find antecedents to this more integrated approach back into the early 1800s. As Leopold was visiting Europe, he became interested in this alternative view, then proceeding through the Dauerwald (or permanent forest) movement, which took a more naturalistic, ecologically oriented approach to managing forests, something that we might call sustainable forestry or perhaps even ecosystem management.

That alternative vision had attracted a growing following, but one of the problems with this alternative approach was that it became tainted with Nazism. This association with Nazism delayed, at least I'm told this by some of my friends in Europe, a serious reconsideration of the technocratic approach to forestry for decades.

Now, in fact, there's a rather lively movement within Germany and across Europe to revisit these alternative approaches and in particular Leopold's contributions. There's a whole gang of German foresters and wildlife biologists and environmentalists who have reread Leopold's writings from his Germany trip and have found them useful because in some ways Leopold was able to see their landscape more clearly than their own foresters.

Leopold returned from that trip

and began to write and think more about the value of diversity, the importance of the higher predators, the health of the forest as a whole. That trip catalyzes the reconfiguration of his own conservation philosophy and the application of his own science.

ER: While he was thinking all these grand thoughts and looking over the horizon, he was also a close observer of nature; he'd be out on his hands and knees studying plants.

Leopold sharpening his prose at the shack.

CM: That is one of the things that distinguished Leopold: this ability to shift his focus from the minute to the global. Leopold was of his generation of conservationists, but there were some important ways in which he was unique within that generation. One was this ability to see both the larger patterns and the details, the forest and the trees. He understood the larger trends affecting the natural world, but he was not content to stay at that level. Leopold was not one to simply sit and say, Oh, the world's going to hell in a hand basket. He had the capacity to understand global interconnections and large-scale changes, but then still move on to ask how we might deal with these forces in a pragmatic and positive way. It was that balance between perspectives, and between action and thought, that distinguished him. And then, of course, there was the way he could write about it.

All of this came together in the report of the Huron Mountain Club. As he saw it, here was 15,000 acres of old-growth forest, one of the last parcels of old-growth left in the upper Great Lakes, under the stewardship of conscientious private landowners. What would you do with it? And he poured into it all of these thoughts that he'd been mulling over in these previous few years. His answer is: we will protect the aesthetic, biological, and wilderness values of this site; we will take into account ecological functions and connections; we will integrate the recreational values in an unobtrusive way; we will encourage research; we will recognize that careful timber production is possible, if that is what the Club members would like to do, and the proceeds could be applied in a productive way also. Leopold's plan offered a way to treat the property in a way that wouldn't diminish its inherent conservation values, that would in fact enhance them. It's a practical application of his large thoughts.

ER: His work for them is sixty years old and still relevant.

CM: The Huron Club report remains relevant and important because of its great value in understanding alternative approaches to managing the upper Great Lakes forests. We're eighty years or more into the second growth phase in this region, and the forests are coming under increasing pressures for their fiber value. As the Northwest timber cut has declined, the timber industry has begun looking back to the upper Great Lakes and to the South. The old-growth forest of the Great Lakes states is long gone. But we don't want to make the same mistake twice.

ER: Cut-and-run logging is not going to happen this time, I hope.

CM: That's one way in which I think the upper Midwest comes to these matters in a different way than the Northwest or Central Rockies. The reason we have large expanses of national forest land out west is because we decimated the upper Great Lakes forests. It was that virtually complete cutting of the pineries through Michigan, Wisconsin, and Minnesota that provided the wake-up call. That experience told us that we could not treat the forests of North America like this any more. We exhausted what was claimed to be an inexhaustible resource, and that led in many ways to the establishment of the Forest Service and the protection of the western forests.

Westerners, especially in the Northwest, did not have the same experience, until recent decades, of seeing such extensive cutting over of the land. In many ways the Northwest has still been fighting the primary battles, whereas a hundred years ago in the Midwest, it was not even a battle, it just happened. Our national forests in the upper Midwest are established mainly on cutover lands. They are forests in recovery. The question is, Can we apply new concepts in forestry, conservation biology, restoration ecology to the recovery and stewardship of the forests here? In some ways we have done a good job of that, in some ways we're still learning, and in some ways we've not done so well.

We also have different pressures in terms of the wildlife species that are especially attractive to so many hunters – ruffed grouse, white-tailed deer, which thrive in early successional forests. But we've also had successes. We've had some amazing recoveries and reintroductions: wolf populations are growing, the martens and fishers and bald eagles have rebounded, our wetlands and waters have recovered from their degraded status to some degree. We have a strong regional movement devoted to restoring tallgrass prairie and savannas. Even the whooping crane is back in Wisconsin, as of this week.

I remember talking to Mike Dombeck about this when he was Chief of the Forest Service. He had been asked to go out and give a talk on the Tongass about the status of the roadless area proposal there. I said, Well, Mike, you're a northern Wisconsin homeboy. If I were giving that speech, I'd talk about how when you grew up in northern Wisconsin you didn't have the opportunity that is still available to people in southwest Alaska; that the type of forest you grew up with was scrawny, second-growth, recovering forest, not the forest that the native Anishinabe and the first European arrivals knew. We lost it all. In Alaska, they still have a chance to keep theirs.

I know that's not going to carry a lot of weight with a heavily invested timber producer looking at prime stands of old growth forest in the Northwest. But it's our history.

ER: Timber companies cry alligator tears for the loggers who are thrown out of work, but they always lay them off when the woods are down.

In cutting over the pineries of the Upper Midwest we exhausted what was claimed to be an inexhaustible resource.

CM: Sure, and there are those who reap great benefit by driving those political wedges as deeply as possible, and keeping them there. One of the encouraging trends I've seen in recent years on this point relates directly back to Leopold. One reason Leopold remains relevant and people still turn to his words and find meaning there is because he strove for a workable synthesis between social and economic realities and ecological realities. He also resisted as much as he could the overt politicization of conservation struggles, although they always have a political dimension to them. He recognized that you have to understand the human connections and bring some sense of humility to these problems. Without that sense of respect and the ability to deal decently with people you might not see eye to eye with, you're not going to get very far. Leopold was a passionate fighter for conservation all his adult life. But he knew how to build trust too.

All this is reflected in the community-based conservation efforts and ecosystem management approaches we see around the country. It is a sea change in the history of conservation. It is a new way of trying to do business. I think of them all as social experiments in conservation. They have the potential to overcome this harsh politicization. But too much distrust has built up over the last few decades, and for good reason, because the political wedges have been driven so deep.

That's one of Leopold's important legacies. He gives us something to stand on, and he provides bridges. Environmentalists, for example, can talk to foresters through Leopold. If you disagree with what has been the dominant mode in forestry, you can use that history to better understand the conflicts as well as the common ground. I don't want to sound pollyannish. The tensions have been building for decades, the pressures continue to mount, and the trends are sobering. But we do have in this country our own long-standing alternative tradition of more integrated approaches to conservation. Leopold is an important part of that tradition, a common reference point. His experience helps us to comprehend that history so that we aren't in defensive mode all the time. His life is a testament to the possibility of positive change.

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[1] University of Wisconsin Press, 1988
[2] See also www.aldoleopold.org

Hawaiian Birds: Evolutionary Treasures Too Valuable To Be Lost

Introduction:

Hawaiian honeycreepers are an apparently diverse assemblage of birds that have evolved on the Hawaiian Islands and exist nowhere else. Honeycreepers are diverse in appearance, some have a spectacular sickle shaped bill while others have shorter, or stouter, or cross bills. But honeycreepers are all descended from a pair of finches that made it out to the islands about 5 million years ago. Since humans settled on the islands however, two-thirds of the honeycreepers have gone extinct, and half of the species that remain are threatened with extinction. We spoke with Professor Leonard Freed of the University of Hawaii about the natural history of honeycreepers and conservation efforts on their behalf.

ER: Professor Freed, what is your training?

LF: I got my Ph.D. at the University of Iowa working on the life history and mating systems of house wrens. Then I spent several years at the Smithsonian Tropical Research Institute in Panama working on tropical house wrens; from there I migrated to Hawaii. I'm a faculty member in the Department of Zoology at the University of Hawaii at Manoa, which is on the island of Oahu, but I do most of my research on the Big Island of Hawaii. I'm also director of Hakalau Forest Biological Field Station, which we've constructed at Hakalau Forest National Wildlife Refuge.

ER: What are your research interests?

LF: As a behavioral ecologist and evolutionary biologist, the pattern of variation in color of plumage in closely related birds on the main Hawaiian Islands is fascinating. I'm particularly interested in the evolution of sexual dichromatism, where males become much brighter than females. We can trace the patterns of that for some of the species to see whether they become more or less sexually dichromatic along the island chain from Kauai to the Big Island.

As a conservation biologist, I am interested in the enormous challenge to save what is left. I have the role of studying the behavioral ecology and evolutionary biology of endangered species. As it turns out, the relevant data for basic and applied research are quite similar.

Within this one closely related set of birds there is a range of bill variation that would be found in diverse families elsewhere...

ER: What is so special about Hawaiian birds?

LF: In two words, Hawaiian Honeycreepers. This group of over sixty species and subspecies, known historically and from the fossil record only from Hawaii, contains a variety of bills and behavior that is extreme among birds. Within the single taxonomic unit of Hawaiian Honeycreepers are species that specialize on seed, insects, fruit, and nectar. The insectivorous honeycreepers are the most diverse, with bill morphology and behavior that specialize on gleaning insects and spiders from leaf surfaces, probing in crevices in bark of trees, opening leaf buds and tightly packed clusters of leaves, and excavating wood for grubs. The evolutionary intrigue is that within this one closely related set of birds there is a range of bill variation that would be found among diverse families of birds elsewhere in the world. We can almost map each species of Hawaiian Honeycreeper to a bird family elsewhere in the world. Of course, this similarity to birds elsewhere in the world is coincidence. Molecular studies of DNA clearly identify Hawaiian Honeycreepers as a closely related group of birds with a single common ancestor, a cardueline finch that could have come either from the Americas or from Asia.

ER: How old are the islands?

LF: If you look at the oldest volcano on each island, Kauai is 5 million years old, Oahu is 3.2 million years old, Maui is about 1.3 million years old, and the Big Island is less than half a million years old. As you go northwest from Kauai, the Hawaiian chain extends past Midway Island. The northwest islands are older than the main islands and used to be larger and higher than they are now.

The Hawaiian Islands are interesting for evolutionary biologists because they formed in chronological sequence. There's a hot spot in the Earth's mantle and as the Pacific plate moved over the hot spot, volcanoes formed the islands. The newly formed islands were slowly carried away to the

northwest by the movement of the Pacific plate. They're being carried away in geological time; estimates of the rate of movement of the Pacific Plate are 8 to 9 centimeters each year. *[About 3.5 inches. Ed.]*

ER: How does the variation in age of the islands pertain to the birds?

LF: DNA studies of Hawaiian Honeycreepers estimate the age of the ancestor to be approximately 5 million years old. This is consistent with Kauai being the island that was initially colonized, and where the diversity of bills, diets, and foraging substrates subsequently evolved for about 2 million years before any of the other main islands were formed. (We call a species of bird with a particular bill/diet/foraging substrate combination an ecomorph.)

Then as Oahu, the next island that formed, developed suitable habitat, we hypothesize a movement of colonizing birds of all the ecomorphs from Kauai to Oahu. Then as Maui, Molokai and Lanai formed, and plants colonized them, and habitat became suitable, there would be dispersal of birds of the different ecomorphs from Oahu; then as the Big Island formed the same thing occurred there.

This model is supported by molecular studies of amakihis. There is a different species or subspecies of amakihi on each of the main islands. These are related in hierarchical fashion: The Kauai Amakihi is ancestral to the Oahu Amakihi, which is ancestral to the Maui Amakihi, which is ancestral to the Hawaii (Big Island) Amakihi.

ER: So bird species are surfing along the islands as they roll by in geological time.

LF: That analogy has been used before, although the usual expression is island hopping. It may be that some of the variations in bill size of birds like amakihis, which vary among the islands, might be related to the order in which species hopped from one island to the next. The amakihi example above suggests that the island hopping is one-way. Not only are the Hawaiian Honeycreepers endemic to Hawaii (evolved there and not found anywhere else), but many species and subspecies of Hawaiian Honeycreepers are endemic to single Hawaiian islands. This indicates that the colonists on the newer island and their immediate ancestors on the older island were undergoing independent evolutionary changes after the colonizing event.

There is nothing more eerie than a great-looking forest that has almost no birds in it.

ER: How do honeycreepers make a living?

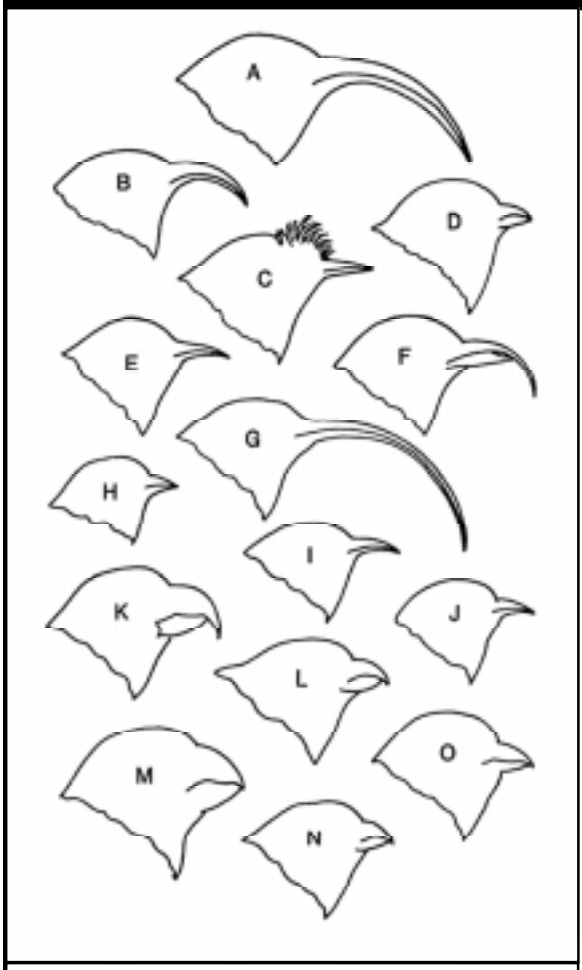
LF: We did a study a number of years ago documenting how the historically known Hawaiian honeycreepers used resources on ohia-lehua trees, *Metrosideros polymorpha*. This tree is the predominant tree in Hawaiian forests. It provides nectar and a diversity of insect and spiders on its bark and foliage. Foraging specializations of Hawaiian Honeycreepers are based largely on ohia-hua trees. So, for example, there are honeycreepers that glean insects and spiders off leaf surfaces; there are honeycreepers that probe shallowly on bark and branches for insects and spiders; there are nectarivorous honeycreepers that feed on flowers. So it's not surprising to see that it's basically the same set of ecomorphs in each one of the Hawaiian Islands.

ER: You're going to have to tell me again what an ecomorph is.

LF: An ecomorph is a type of forager. The bill shape and size indicates the type of food that bird could use, so when we identify different forging modes, we can refer to the morphology of the bird as an ecomorph. The concept works because the bills of birds are highly adapted to their foraging specializations.

For example, the akepa is an ecomorph for opening leaf buds to get at caterpillars. This bird has converged (undergone similar natural selective pressures) with crossbills in North America in that the two jaws are asymmetric from curvature of the lower bill. The jaw musculature is also asymmetric, and so there are akepa that have right-crossing bills and akepa that have left-crossing bills. With this crossing of the top and bottom bills they can pry open densely packed leaves to get at insects or spiders or even open up some of the ohia leaf buds to get at caterpillars. So we call the akepa a leaf bud opening ecomorph. There are or were akepa species or subspecies on each of the main islands with this ecomorphology and behavior.

There are amakihis on each of the main Hawaiian Islands, and they have a generalized gleaning bill used to glean insects and spiders off of leaf surfaces. We call that a foliage-



Honeycreepers all are descended from a finch-like ancestor.

gleaning ecomorph.

The reason why we use that terminology is that there are a number of different honeycreepers and they are not related to each other as closely as it might appear if you just judged by their morphology. There has been convergent evolution of the creeper ecomorph (probing bark for insects and spiders), independently from different Hawaiian Honeycreepers. So we look at a bird in an ohia forest as the creeper ecomorph. Unlike the akepas and amakihis, there are two or perhaps even three species of creepers among the main Hawaiian Islands that independently evolve the behavior and morphology of probing bark.

ER: Where is your field station?

LF: It is on the windward slope of Mauna Kea (on the Big Island) at an elevation of about 6400 feet. It's near an old-growth ohia-koa, *Acacia koa* forest. This is the combination of tree species in Hawaii with the greatest number of ecomorphs, including wood excavators that specialize on koa. In fact, most of the forests in Hawaii have very few numbers of tree species and usually the ohia tree is the predominant one. The koa tree is also an emerging canopy tree.

ER: Hawaii is well known for its conservation problems.

LF: Indeed it is. Up to now, we have discussed items of interest to evolutionary biologists. However, only about one third of the over one hundred species and subspecies of landbirds known historically and from the fossil record are extant today, and about half of these are endangered. Hakalau Forest National Wildlife Refuge, where the field station is located, is the only national wildlife refuge in the United States on which endangered predators (Hawaiian Hawk) feed on endangered prey.

ER: Which group of honeycreepers is in trouble?

LF: It's the specialized insectivorous ecomorphs that are endangered on each island. The nectarivorous ecomorphs like iiwis and apapanes are not listed, although the iwii is considered a species at risk and the Akohekohe is a Maui endemic that is listed. But in general, it's the same birds that are extinct, the same birds that are endangered, and the same birds that are not listed on each one of the main islands. That suggests that the threats to them are similar on each of the main islands.

ER: What are these threats?

LF: Three species of rats have been introduced to Hawaii. We know from studies on Oahu that rats can depredate nests of native birds, and there is some evidence of that on birds even in ohia forests where nests are much higher in the trees.

There are feral cats, and on several islands there are mongooses that were introduced at low elevations to control rats and then naturalized at upper elevations. These predators can depredate adult birds as well as nests.

There are also a large number of introduced birds that have naturalized in Hawaii. Some of them may be competitors with native birds, but there's not enough good evidence of that yet. However, the introduced birds were a source of avian malaria and pox virus. Many of the introduced birds were intentionally introduced. With the inadvertent introduction of a mosquito vector (southern house mosquito, *Culex quinquefasciatus*), disease became a major problem. After all, these birds evolved for 5 million years in the absence of mosquito-transmitted diseases, so it is no surprise that they are susceptible to these diseases.

Then a number of ungulates have been introduced, particularly pigs and feral cows. Those animals can degrade

the understory of a forest so any of the birds that would have used some of those understory resources are out of luck.

ER: Why are the insectivorous birds taking the major hit on all the different islands.

LF: Insectivorous birds have a lower reproductive rate than the nectarivorous birds; they also are more philopatric, meaning that they have much lower dispersal. The hatch year birds tend to stay in the same area.

What you have in the insectivorous birds is the classic conservation problem of a species with long-lived adults and a low reproductive rate combined with not much dispersal. Those birds, first of all, are specialized in their foraging and as their habitat is degraded they can't expand their foraging niche. And their low reproductive rate means there's less opportunity for natural selection to operate on them compared to birds with higher reproductive rates. Their high philopatry means that we can't count on colonization when a portion of their population has been extirpated.

ER: Can you elaborate on disease as a threat?

LF: J. Michael Scott was head of the Hawaii forest bird survey in the late 1970s and early 1980s. It was that marvelous effort that documented many distributional anomalies; that is, areas where some bird species were inexplicably rare or absent despite suitable or even pristine forest. He tried to account for elevational distributional anomalies in terms of disease.

That altitude below which the endangered birds on the mountain slope no longer exist is called the mosquito line. There's a negative correlation between the presence of endangered birds and even the abundance of the non-endangered birds and the presence of the mosquitoes.

There are also some lateral distributional anomalies within elevations, where some birds are inexplicably rare, in which disease has been invoked as an explanation.

There is nothing more eerie than a great-looking forest that has almost no endangered birds in it or just few individuals of the more common species. The classic conservation problem of low reproductive rate and limited dispersal of the endangered birds directly pertains to disease. With fewer offspring, there is less chance each generation for a favorable mutation with respect to disease to appear in the population. With limited dispersal, favorable mutations that might arise are unlikely to spread throughout the population.

ER: Has anyone been working on the distributional anomalies?

LF: There have been several comparative studies along lateral gradients. The USGS-BRD compared predators along a gradient in decline of the endangered birds, and found no difference in density of predators that could account for the decline of the birds.

I've worked with some of my former students (Patrick Hart) to investigate variation in density of the Hawaii Akepa, one of the endangered birds. At Hakalau, the bird has a three-to-one decline in density over a three-kilometer distance in continuous forest at upper elevation. This bird is the only honeycreeper that nests in cavities. Those cavities form naturally, since there are no woodpeckers or other birds in Hawaii that form the cavities. We have determined that cavities form only in very large ohia and koa trees. We looked at the possibility that the difference in density of these birds would be based on carrying capacity of nesting sites. We predicted that the three-to-one difference in density would be matched by a three-to-one difference in trees with cavities. That was what we found.

We also compared the basic fitness of the birds in the low-density and high-density populations. We found that reproductive success was the same, annual adult survival was the same, and weights and fat levels were the same. These comparisons can exclude factors like differential predation, disease, or food as the causes of the decline in density.

This was clearly a case where this bird had such a specialized niche requirement for nesting that the abundance of that resource dictated the densities of the birds. You go can a little farther at that same elevation and the bird falls out completely, despite

the fact that there are still sufficient big trees to support some population. But at least we know that some of the variation in density is based on quality of the forest. Different factors may operate at different areas along a gradient in density.

We got a grant from the Environmental Protection Agency to build some camps and go down to the bottom of the range of these birds and to see whether mosquito-transmitted disease is responsible for the end of their range, even within continuous habitat. We used the Hawaii akepa as a model. Habitat degradation at upper elevations may make treefall of large trees with cavities higher than it would be otherwise, and that the stress of infectious disease plays a role in the lower portion of the range of the bird.

ER: How high is the mosquito line?

LF: The mosquito line has been estimated at 5000 feet, at the 5000-foot elevation or 1500-meter elevation, which is a little less than 5000 feet. There's never been a formal study of exactly where the line is in remote continuous forest.

It does appear to be higher on the Kona side of the big island. That is, mosquitoes make it to higher elevations in Kona, and it's thought that the limits of their elevation would be temperature. The issue becomes even trickier because the malarial parasite doesn't do well in the mosquito when it gets too cold. It turns out that mosquitoes do better at upper elevations than does the malarial parasite, so it may be that as you go from the top of the range of some of these birds down through the bottom of their range that the first thing that they get exposed to would be pox virus that is mosquito transmitted, and then perhaps even lower than that is where they would be exposed to malaria as well.

ER: Are they any places on Kauai or Oahu that are over 5000 feet?

LF: No. Kauai may have an advantage in that the Alakai plateau is sufficiently flat that there is protection from the normal tradewinds that might transport infectious mosquitoes from lower elevations. Topography may thus play a role in addition to elevation. But there still is malaria and pox virus up there.

Oahu is an interesting spot. The Oahu amakihi underwent a decline in the middle of the last century and then started a comeback. We've been studying it at Lyon Arboretum, which is at about 1000-foot elevation and it's loaded with mosquitoes.

It's the specialized insect eaters that are endangered on each island

ER: I've been run out of there by the bugs.

LF: But not by *Culex* mosquitoes unless you were there at night. My wife, Professor Rebecca Cann, has developed a molecular diagnostic that can detect low levels of malaria in the blood of birds. She and her students have documented that the Oahu amakihi has apparently evolved resistance to malaria, and so that bird may become the Rosetta stone for eventually being able to find out the nature of the genetic loci that confer the tolerance. High prevalence of malaria is maintained in the many introduced birds at Lyon Arboretum, so it is very significant that none of 28 amakihi samples tested positive.

ER: Has any thought been given to bioengineering in the conservation context?

LF: Indeed there has. I'm on the Hawaii Forest Bird Recovery Team, and we have a new draft recovery plan with the bottom dollar figure of $2.8 billion, which includes a lot of bioengineering. There are plans for documenting tolerance or resistance and looking at the heritability of the characters, and possibly even looking at the linkage of these characters with genetic markers. In principle, once we identify genes that may confer tolerance or resistance, we can document the proportion of individuals in a population that have the appropriate alleles. *[Alleles are minor variations in the same gene. Ed.]*

One strategy might be to find some individuals of the endangered species that have malaria but still survive and reproduce well. That would indicate that they at least tolerate it. So if we can find individuals like that and if we can determine whether tolerance is a heritable character, then we would know which sires and dams to be used in captive breeding to produce offspring that would have the desired genetic characteristics to tolerate this disease.

ER: That could also help the understanding of human malaria.

LF: I think so, especially because there's an indication that human malaria is closely related to avian malaria. Of course, there are many different mechanisms by which tolerance or resistance is expressed, so the avian solutions and human solu-

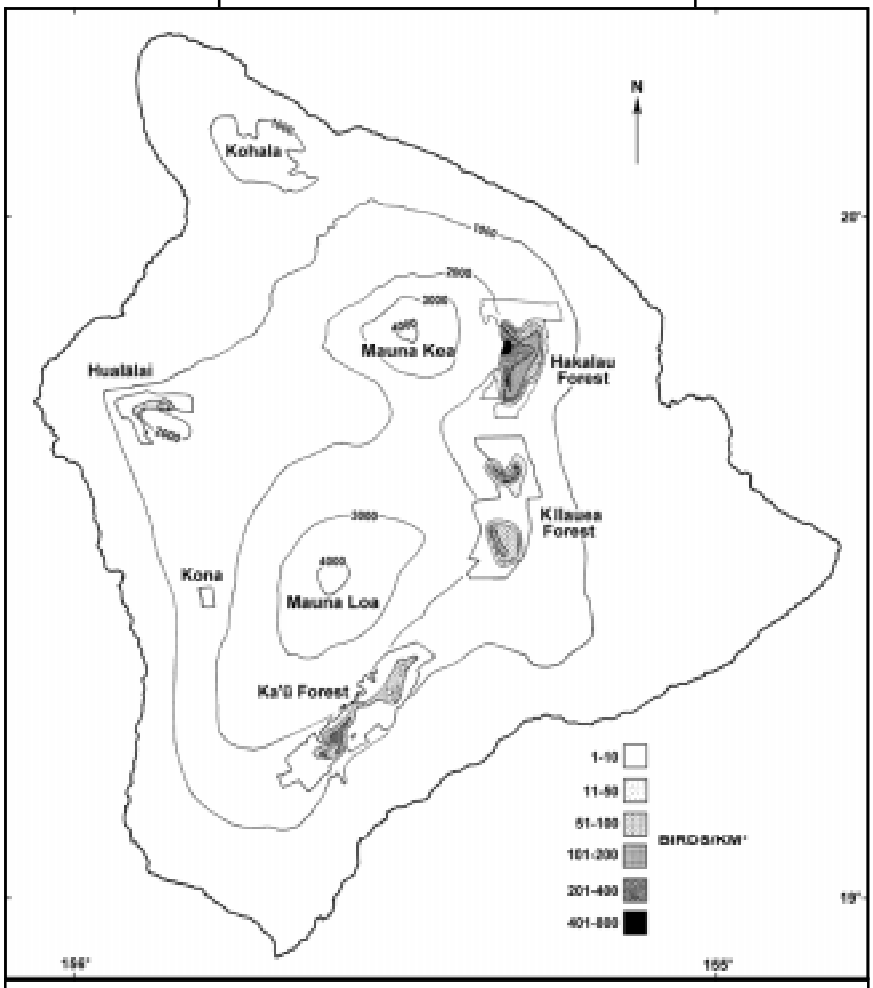
tions may be quite different.

ER: What are the most important threats to their survival?

LF: Without a doubt disease is the number one priority threat. That is because there can be the evolution of virulence in malaria or pox virus and in a short period of time wipe out a lot of birds. Certainly a major portion of the plan deals with the research and management that needs to be done with disease.

Another major effort specified in the recovery plan is predator control. We know from the high adult survival and low reproductive rate of endangered birds that a reduction in adult survival will have a larger impact than a reduction in the reproductive rate. Another major component of the recovery plan is regeneration and restoration of habitat. There is a lot of upper-elevation habitat that used to be forest that is now pasture. In principle we would attempt to replace the pasture with ohia and koa trees. This is a difficult problem because it freezes at night during the winter at upper elevations and competition with grass roots may overwhelm slow-growing ohia seedlings. Land acquisition, building of ungulate proof fences, and ungulate eradication are part of regeneration and restoration of habitat.

ER: What is in the recovery plan besides dealing with those threats?



Honeycreepers on the Big Island (Hawaii) occupy a small fraction of their former range.

LF: There are two other components to the plan. One is captive breeding. There needs to be the basic work of getting some of these specialized birds to not only stay alive in captivity but to breed in captivity. There is a priority to develop that, and now is the time to make the mistakes. You don't want to make the mistakes when there are two or three individuals left. You want to make the mistakes when there are 10,000 individuals left.

Then there is a component that deals with public education. Relatively few people in the State of Hawaii are aware of the evolutionary treasures that are here. Unless there is some formal education, the typical student on Oahu would not know that Hawaiian honeycreepers exist because they never see them.

ER: All I see are introduced birds when I go there.

LF: You'll see bulbuls and mynahs. As an ornithologist at the University I get calls from the public all the time. One lady called and said, "I'm looking for somebody who's an expert that can help me out with my problems with the state." I said, "What's that?" She goes, "Well, I have a young bulbul and the state is telling me that it's illegal for me to have it because it's an introduced bird." She didn't mention that it's also an official pest. She said, "I need somebody to convince the state that it's not an introduced bird." I said, "Lady, the red-whiskered bulbul is most

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January - December (2001)

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definitely an introduced bird." She said, "No, maybe the first one, the first set that were brought here were introduced birds, but this one was born in Hawaii and thus it's a native bird." I said, "Lady, I'm afraid that evolutionary biologists don't recognize kamaaina organisms." When I teach Ecology and Evolution to nonmajors, I use this humorous story because the students all know that kamaaina means being born in Hawaii, or living here long enough to be considered real residents.

ER: That makes it an American citizen anyway. How many species are you talking about in the recovery plan?

LF: We're dealing with the listed ones. We are dealing with all of the listed forest birds of the main Hawaiian Islands except the Hawaiian Crow and Hawaiian Hawk, which have their own recovery teams and plans. We are thus dealing with twenty-one species or subspecies. In some cases these birds are so rare we don't even know if they're extinct or not. We have a rare bird protocol where there will be periodic censuses done in some of the remote areas where these birds might still exist. Then we have a detailed step down that we would use if one of these is detected. A set of researchers would be mobilized to go in there and try to see if there is more than one and, in particular, to engage in some of the most intensive management of threats within that particular area.

NEXT MONTH

PIPING PLOVER CONSERVATION
Michael Larson

BLUE FIN TUNA: WILL THEY BE ALLOWED TO RECOVER?
Beth Babcock

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