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Research Station

Science
FINDINGS

INSIDE

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"Science affects the way we think together."
Lewis Thomas

CONSERVATION OF BIOLOGICAL DIVERSITY: ALL THINGS CONSIDERED

Bruce G. Marcot

Van Dyke's salamander might be one of the rarest vertebrates in the Pacific Northwest. They live in the splash zone of clear creeks and waterfalls in western Washington.

"When one tugs at a single thing in nature, one finds it attached to the rest of the world."
—John Muir

The status of most of the world's species is a complete mystery to science. By some estimates, more than 90 percent of species have never even been described, let alone studied in depth. This hidden biological diversity is not just relegated to far-flung tropical rain forests; many species in North American forests are known only through a handful of observations, and new species are still being discovered. Of course, it is not the large and charismatic creatures that are a mystery (sorry, Sasquatch hunters), but rather, the mollusks, mosses, and salamanders are what remain inscrutable.

This raises a quandary for land managers who are regularly directed to retain ecological integrity and preclude trends toward species listing under the Endangered Species Act (ESA). How do you conserve what you don't understand?

The challenge of conserving rare or little-known species was crystallized when, in 1994, a team of federal agency researchers, managers, and university professors was directed to develop the scientific basis for a management plan that would ensure the continued viability of all species known or suspected to be associated with old-growth forests in the Pacific Northwest. The team entered deliberations with a list of over 1,100 species and species groups. After several months of analyses, they emerged with a scenario that relied on a network of forest reserves to protect the bulk of

IN SUMMARY

Most ecosystems contain a few common species and many rare ones. By virtue of being rare, these species are often poorly understood and difficult to manage. Scientists at the PNW Research Station have recently published a landmark book that chronicles what is known and what they've recently learned about conserving cryptic biodiversity. For the past decade, federal land managers in the Pacific Northwest have been faced with the unprecedented challenge of ensuring the protection of more than 400 rare or little-known species, mostly fungi, lichen, mollusks, and amphibians thought to be associated with old-growth forests. Expertise gained regionally in the Northwest was synthesized with national and international approaches to species and systems management in the book Conservation of Rare or Little-Known Species: Biological, Social, and Economic Considerations.

The book represents one of the first major attempts to address the protection of the scarce, hidden, and often noncharismatic species that may often be ignored during conservation planning. It reviews existing strategies to conserve biodiversity and evaluates their ability to address rare or little-known species. The authors stress the importance of integrating the legal, social, and economic environments in which planning occurs, and they outline many of the opportunities and challenges that exist therein. Finally, the authors offer a procedure for merging species and system approaches in an adaptive management framework to aid conservation of rare or little-known species and to help practitioners respond to new information.

the species. But a whittled version of the list—containing 404 species—still remained. These species, according to the experts, may be associated with old-growth forests, or they may not. They may be imperiled, or they may not. They may be adequately protected by the forest reserves, or they may not. There was simply not enough information on which to base an informed opinion.

"The species were either exceedingly rare or so poorly understood that their status could not be determined with any degree of confidence," explains Martin Raphael, a research wildlife biologist at the PNW Research Station in Olympia, Washington. The fate of these 404 species became the explicit responsibility of the federal land management agencies, codified in the "Survey and Manage" species list of the Northwest Forest Plan.

"The Survey and Manage Program was unparalleled in size and scope. It addressed hundreds of rare or poorly known species of amphibians, moss, lichen, fungi, mollusks, and arthropods that had never been considered for individual protection on federal land," says Raphael.

"The program used an adaptive approach, protecting known sites and collecting new information to address concerns for species persistence and to develop management strategies," adds Randy Molina, a recently retired botanist and mycologist at the PNW Research Station in Corvallis, Oregon, who actively participated in the Survey and Manage Program.

Survey and Manage became one of the most complex, expensive, and controversial aspects of the Northwest Forest Plan. "The costs and technological challenges of carrying out a conservation program for such a large number of organisms—moreover, doing so in an environment with significant uncertainty and political controversy—are staggering," explains Raphael.

In the fall of 2003, after almost a decade of experience and more than a little frustration, the agencies responsible for implementing the Survey and Manage Program hosted a conference to air some of the social and ecological issues associated with the conservation of rare or little-known species. The conference planted a seed for a book that would assemble much of what had been learned through the Survey and Manage Program and other efforts to conserve cryptic species throughout the world.

"It grew out of a need to synthesize scientific information and thinking and apply it to real world problems, for which there were no obvious solutions," says Raphael. That book, edited by Raphael and Molina and titled *Conservation of Rare or Little-Known Species: Biological, Social, and Economic Considerations*, was recently published by Island Press.

KEY FINDINGS

- Most species are exceedingly rare or poorly understood. This means that their conservation status cannot be determined with any degree of confidence, yet their need for conservation may be paramount.
- The Survey and Manage Program of the federal Northwest Forest Plan represented an unparalleled opportunity to increase understanding of rare or little-known species and to develop strategies for their conservation. This program has led to approaches to managing for biodiversity, beyond a few charismatic species, that may be applicable in many places worldwide.
- The book *Conservation of Rare or Little-Known Species* reviews and synthesizes species- and system-level approaches to managing these challenging organisms in an ecological, social, and economic context.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

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Bruce G. Marcot

Soil springtails, seen here at 200× magnification, are an abundant but little-studied group of species in Pacific Northwest forests that play a major ecological role. These tiny animals occur in high numbers in upper soil layers and help create topsoil by decomposing soil fungi, lichens, bacteria, and plants.

WRITER'S PROFILE

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SAVING ALL THE PIECES

Much has been written about conserving rare species. After all, each species we know to be imperiled or listed under the federal ESA is, by definition, rare. But what we know about rarity and conservation is overwhelmingly based on large and well-known species such as spotted owls, grizzly bears, and bald eagles. "However, in most ecosystems, the vast majority of species are either rare or poorly known and they have received paltry coverage in the conservation biology literature," says Raphael. In this way, the book fills a critical niche.

Furthermore, as Molina points out, "many little-known species perform critical ecosystem functions, including cycling nutrients, improving soil structure, and linking food webs."

"Rare or little-known species pose special problems to conservation management," says Bruce Marcot, a research wildlife biologist at the PNW Research Station in Portland, Oregon, and a major contributor to the book. "It is difficult to detect and study rare species, and they do not lend themselves to experimentation."

In one chapter, Marcot and Molina review some of the special methods for surveying and sampling for species when data points are few and far between. They also evaluate some of the statistical and modeling considerations that scientists and managers can use when working with high levels of uncertainty.

Methods described were informed by work done for the Survey and Manage Program, which has developed a vast body of knowledge regarding the previously unknown species. "From the sheer number of known site records obtained after 10 years of surveys, efforts appear remarkably effective. New data have reduced uncertainty and persistence concerns for more than 100 species, which were subsequently removed from the Survey and Manage Program," says Molina.

"Surveys for rare salamanders have vastly improved our understanding of species distributions. In one case a new species of salamander was found through these efforts, and in another case, surveys led to development of a species-specific conservation strategy, where we could select a subset of sites for conservation emphasis" adds Deanna Olson, a research ecologist at the PNW Research Station in Corvallis, Oregon.

But conserving these species requires more than a technical fix. Little-known species also present a host of unique social and economic problems. For one thing, "Few people are going to raise the flag of protest for some tiny mollusk, even if it is a critical part of the ecosystem," says Raphael.

Sarah Jovan

This scarce lichen, Lobaria hallii*, is very sensitive to air pollutants and is considered ecologically important because it processes atmospheric nitrogen into a form that plants can use.*

Accordingly, the book includes a contribution by John Peine, a research sociologist for the U.S. Geological Survey who specializes in social perspectives on ecosystem management. Peine discusses the legal and institutional setting in which conservation planning occurs, and he shows that there are commonalities among management programs that succeed and among those that fail. Those that succeed all take a holistic view that "brings all stakeholders involved in environmental disputes together to work out differences."

Olson agrees: "In the development of a successful conservation program, some of the key considerations have socioeconomic elements, such as the authority to implement the program, capability in terms of funds and personnel, and accountability to report back to stakeholders and demonstrate that the program is being monitored and improved."

Science Findings is online at: http://www.fs.fed.us/pnw/

The site also includes **Science Update**—scientific knowledge for pressing decisions about controversial natural resource and environmental issues.

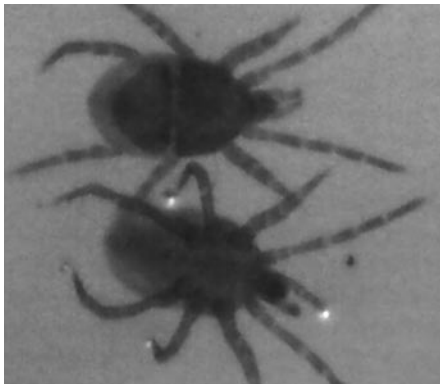
SPECIES APPROACHES TO CONSERVATION

The book includes an exhaustive review of existing strategies to conserve biodiversity and an evaluation of their ability to address little-known species. Within the review, the authors identify two broad categories: species approaches and system approaches to conservation. Species approaches focus on providing for individual species or groups of species with common needs, whereas system approaches focus on providing for community or ecosystem composition, structure, or function.

The ESA, with its detailed biological opinions and critical habitat designations, is the quintessential species-based approach to conservation.

At its best, the ESA relies on population viability analysis, which is perhaps the most reliable way to evaluate the persistence of a species over time. "The main assumption of the population viability approach is that enough is known about the ecology, dispersal, and demography of a species to reasonably predict future sizes of populations and distributions of organisms, from which probabilities of persistence can be estimated," explains Marcot.

"And while there is no substitute for detailed ecological studies of species," says Marcot, "this information is unavailable for the vast majority of species." That is why the authors suggest that, if this type of analysis is desired for little-known species, a "softer" viability analysis—one that relies on expert opinion and potential stressors—will be needed.



Bruce G. Marcot

*These soil mites (*Pergamasus *sp.), shown here at 60× magnification, are numerous, although many species are poorly known or undescribed. They help maintain soil fertility and structure by eating plant and animal residues and other soil fungi and bacteria.*

After all, if you have all the information necessary to conduct a viability analysis, then it's no longer a little-known species.

"In most cases, relying on population viability analysis will cause you to run out of funds and expertise in a hurry," says Raphael. "That's why true viability studies have only been done on a handful of species."

Some species approaches focus on meeting the needs of a surrogate species as a more practical way to conserve rare or little-known biodiversity. For example, managing for an "umbrella species" is an approach that assumes that if the needs of one wide-ranging species are met, then many other species with overlapping habitat requirements will be covered under the "umbrella." The northern spotted owl, which has a geographic range including old forests across the Pacific Northwest, has been used as an umbrella species to conserve a wide array of old-growth species and communities.

The book reviews these and other species approaches, including many that use various kinds of surrogate species to provide for rare or little-known diversity.

SYSTEM APPROACHES TO CONSERVATION

System approaches are often referred to as "coarse-filter" conservation because rather than focusing on the needs of any individual species, they cast a wide net and provide a mix of habitat and environmental conditions. "It's an appealing idea in general that if you can provide the suite of conditions in which all species evolved, then those species should be cared for," says Raphael.

"Managing ecosystems under a coarse-filter approach usually entails delineating reserve areas and restoring natural patterns or processes of landscape-scale disturbances such as fire," explains Molina.

At the simplest level, a system approach is a nature reserve. The National Wildlife Refuge System, or even the National Park System, might be considered a system approach to conservation. Although they might have multiple additional objectives, each protected area effectively conserves known or little-known species.

Other system approaches are more nuanced. For example, managers may try to estimate and emulate the "historical range of natural variability" of some ecosystem component, such as standing dead trees or extent of mature forest. Through fire scars and tree rings, ecologists may estimate the distribution of conditions that occurred across a given landscape before Euro-American settlement, or whenever the region supported the desired suite of organisms. Using prescribed fire and silviculture, managers can then emulate the natural disturbance regime and, hopefully, provide the proper range of conditions that once supported all the native species.

"Of course, the risk when relying on system approaches is that some species will fall through the cracks," says Raphael. "The rare or little-known species may go unprotected without anyone ever knowing it."

And, as Marcot points out, "managing for rare or little-known species is not necessarily the same as managing for broader system-level performance."

Bruce G. Marcot

A system approach to evaluating forest landscapes for conserving rare or little-known species could relate the current proportions in various growth stages to expected proportions under a range of natural variability. In this case, timber harvesting has resulted in a patchwork of growth stages in which different sets of species might reside.

SHEDDING LIGHT ON HIDDEN DIVERSITY

There is broad agreement that successful conservation of rare or little-known species lies in some combination of species and system approaches. Exactly what that combination will look like boils down to the resources that are available, the social and economic environment, and risk tolerance.

"If resources are limited and your tolerance for risk is high, then you will likely end up relying more on system approaches," says Raphael. "If you are risk adverse or can afford to dedicate a lot of resources toward research and management, then you may rely more on species approaches."

Ray Davis

Lessons learned from implementation of the Survey and Manage Program, such as the value of conducting strategic surveys, are now benefitting other species such as this foothill yellow-legged frog.

In the book, the authors draw on examples from around the world to create an overall procedure for conserving rare or little-known species within the realities of practicing ecosystem management. Their process combines social, economic, and biological objectives at the start. Then a risk assessment identifies the major threats to the species and the management sideboards. From there, a combination of approaches that best address the risk factors can be developed and a monitoring program designed.

"I think the federal Northwest Forest Plan is a good example of mixing approaches and finding a good balance," says Raphael. "The network of old-growth reserves was the foundation of a system approach, while detailed analysis of the northern spotted owl, marbled murrelet, salmon, and other species associated with older-forest habitats tried to ensure, using a species approach, that nothing was falling through the cracks."

Bruce G. Marcot

From a system perspective, a mix of growth stages and key habitat conditions, such as snags and down wood resulting from fire, will likely provide suitable habitat for a variety of rare or little-known species.

"The Survey and Manage Program addressed and considerably reduced uncertainty about conservation of a number of species," says Molina. "Whether perceived as a visionary conservation program or simply an experiment of unbridled management complexity, the program accrued important gains in knowledge and developed new methods that will prove valuable in future management planning and implementation at many scales."

"Conservation is a state of harmony between man and land."
—Aldo Leopold

FOR FURTHER READING

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LAND MANAGEMENT IMPLICATIONS

- Combining a mixed program of species- and system-specific management with a learning plan to accrue new knowledge may most effectively address the conservation of rare or little-known species.
- Conservation programs are most successful when they involve social and economic considerations from the start, in addition to biological objectives.

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