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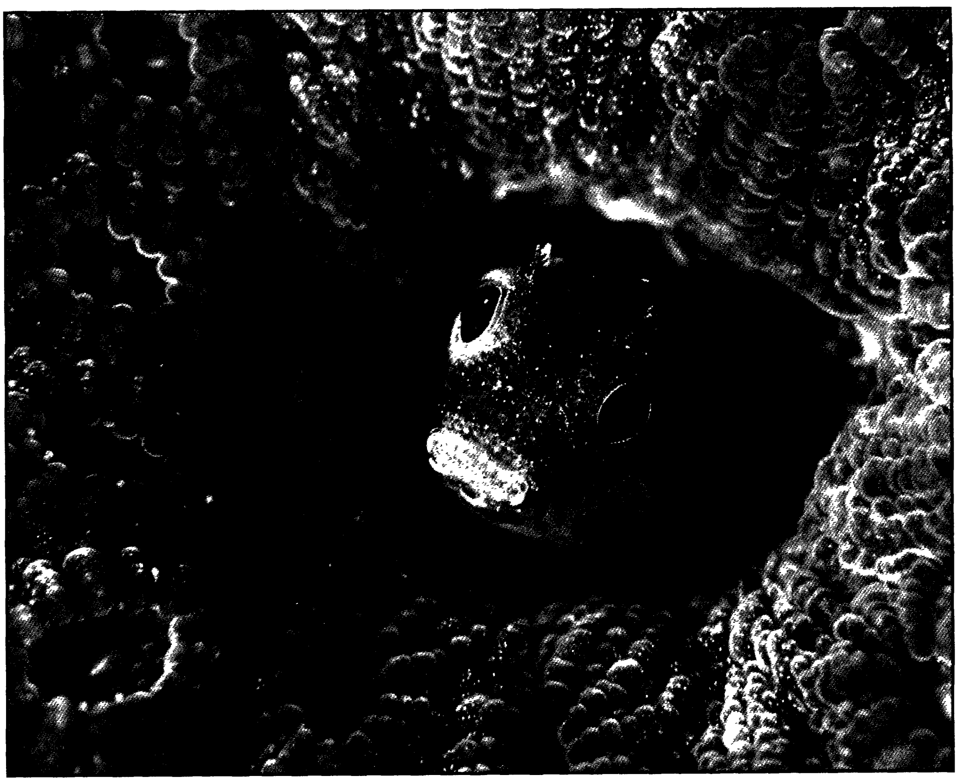

Opinion

Conservation of Biodiversity in a World of Use

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Over the last decade biodiversity conservation has become an objective of international conventions, national governments, state agencies, non-governmental organizations, local communities, school clubs, and individuals. Unfortunately, while becoming a common objective, the true meaning of biodiversity conservation has been pulled from its roots in the biological sciences, becoming a political concept with as many meanings as it has advocates. This confusion of meanings can frustrate efforts to mobilize conservation action, because successful conservation relies on clear goals laid out with specific and commonly understood definitions and assumptions.

Of the many confusing concepts associated with biodiversity conservation, few demand greater definition and scrutiny than "conservation through use," sometimes known as "compatible" or "sustainable" use. At face value these terms suggest that certain types or levels of human use are ecologically benign, incurring little or no loss of biodiversity. In fact, it was the promise that such human use would serve as the basis for conservation that brought so many different interest groups to agree on the importance of biodiversity conservation. Advocates of compatible use have suggested that substituting a compatible use for an incompatible one, or helping to perpetuate an existing use deemed as being compatible, is a reasonable strategy for conserving biodiversity. But strong warnings have been issued by conservation biologists such as Freese (1998): "Human intervention in an ecosystem for commercial purposes inevitably alters and generally simplifies, at some scale, ecosystem structure, composition, and function."

We maintain that compatibility between human use and biodiversity conservation cannot be stated in binary terms as a "yes" or "no" condition. All use has consequences. Different kinds and intensities of human use af fect various aspects or components of biodiversity to differing degrees. Further, individual or societal decisions about the degree of biodiversity impact that is deemed "compatible" are value dependent and should be recognized as such. In reality, the incidence, the source, and the effects of many changes are often unclear, and that lack of clarity impedes action on both political and practical levels.

Because the interaction between biodiversity and human use results in such complex impacts and variable degrees of conservation, we believe that some means of measuring the success of biodiversity conservation efforts is desperately needed. In that spirit, we have proposed a heuristic framework for measuring the consequences of human use for biodiversity. This framework builds from a matrix presented by Noss (1990) and draws from a very specific definition of biodiversity.

Biodiversity refers to the *natural* variety and variability among living organisms, the ecological complexes in which they naturally occur, and the ways in which they interact with each other and with the physical environment. Biodiversity has three different components: genetic, population/species, and community/ecosystem. Each of these components has compositional, structural, and functional attributes. *Composition* refers to the identity and variety of elements in each of the biodiversity components. *Structure* refers to the physical organization or pattern of the elements. *Function* refers to ecological or evolutionary processes acting among the elements.

We suggest that the effects of human use or alteration on biodiversity can be assessed with our framework by determining how different types and intensities of resource use affect

(continued on page 4...)

This editorial is reprinted from Wild Earth (2000), 10:2, 9-11, with permission. Please consult Conservation Biology (1999), 13:1246-1256, for an expanded treatment of the analysis and a full list of references.

Note from the Editors

In an effort to learn more about our readers and how to serve you better, we included a survey in our May/June 2000 issue (Volume 17 Number 3). Fifty-five readers responded—a summary of their responses follows.

In an effort to cut costs and paper consumption, we are considering offering electronic subscriptions. Fifteen (27 percent) respondents were willing to pay a reduced fee for just an electronic copy of the *UPDATE*. Most of the respondents (64 percent), however, would prefer to receive a hard copy as well.

In addition to cutting costs, we want to increase the number of subscribers. To do this, we wanted to know where our readers work and how they initially heard of the *UPDATE*. The majority of you work or volunteer for a conservation organization (45 percent), the government (35 percent), or for an educational facility (27 percent) or university (22 percent). Ten (18 percent) are associated with a zoo, nine (16 percent) with a commercial business, and seven (13 percent) with a library. (Many people checked multiple categories, so these percentages equal more than 100 percent.)

Most of our readers initially heard about the *UPDATE* through a friend or colleague (29 percent) or their workplace (27 percent). Nineteen percent discovered the *UPDATE* through a journal article reference, and only four percent of you heard about us at a conference or meeting or on the web. On average, five people per household or business read the *UPDATE*.

Finally, we asked for feedback on aspects of the *UPDATE* that you particularly like or dislike. In addition to some wonderful compliments, we received some very helpful suggestions, most revolving around the *UPDATE*'s content. For example, readers want more articles on plant conservation, human impacts on threatened and endangered species, conservation policy, status of specific species, and regional conservation efforts.

Overall, your comments and responses were incredibly helpful. Thank you.

If you were unable to complete the survey last summer, you will receive a copy in your next renewal notice—and we hope you will take the time to return it with your subscription renewal.

Endangered Species UPDATE

A forum for information exchange on endangered species issues January/February 2001 Vol. 18 No. 1

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Cover: The Secretary Blenny (*Acanthemblemaria maria*) calls threatened coral reef habitat home. Photo used with permission, ©2000, Barry Lipman/www.barrylipman.com.

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both the components of biodiversity and their attributes as defined above. In order to test the application of the framework, we examined conservation efforts at two sites where The Nature Conservancy has been working: the Roanoke River in North Carolina and the Pantanal in Brazil. We then additionally tested the framework against illustrative examples of human resource use from the literature.

The results of our assessments demonstrate that the full range and expression of biodiversity components and attributes can be conserved only in ecological systems that are altered either very little or not at all. In those systems in which human impacts are more pronounced, the different biodiversity components and attributes are often affected. Some of these components and attributes are more sensitive to human use, while others are more robust. For example, genetic effects appear under much lighter regimes of use than do changes in ecosystem function.

We found that all consumptive use affects biodiversity in some attribute or component, commonly affecting not only the target component but other components as well. For example, the genetic component has been shown to be adversely affected by harvesting, be it fishing, logging, or trophy hunting. The population/species component is most commonly understood to be affected by human uses, and much work has demonstrated this, although subtle effects are often missed. Of increasing importance is an understanding of how the community/ecosystem component has been and is being affected by human activities. The extent to which the different attributes are affected by use remains a little understood and important topic for further research.

BIODIVERSITY COMPONENT AND ATTRIBUTE	TYPES OF USE						
	Irrigation Supply Resevoirs[1]	Hydropower Dams[2]	Intensive Coral Reef Fishing[3]	Grazing in Historically Ungrazed Forests[4]	Water Diversion[5]	Harvesting Nontimber Forests Products[6]	Wilderness River Running[7]
COMMUNITY / ECOSYSTEM							
function	○	⊘	⊘	⊘	●	●	●
structure	○	⊘	⊘	⊘	●	●	●
composition	○	⊘	⊘	⊘	⊘	●	●
POPULATION / SPECIES							
function	○	○	○	⊘	⊘	⊘	●
structure	○	○	○	⊘	⊘	⊘	●
composition	○	○	○	⊘	⊘	⊘	●
GENETIC							
function	○	○	○	⊘	⊘	⊘	●
structure	○	○	○	⊘	⊘	⊘	●
composition	○	○	○	⊘	⊘	⊘	●

○ *not conserved* ⊘ *partially conserved* ● *completely conserved*

[1] Western North America: Rood & Mahoney 1990; Poff et al. 1997.
[2] Global: Cushman 1985; Moog 1993.
[3] Global: Roberts 1995; Laikre & Ryman 1996.
[4] Western U.S.: Belsky & Blumenthal 1997.
[5] California, U.S.: Harris et al. 1987; Stromberg & Patten 1992.
[6] Tropical forests: O'Brien & Kinnaird 1996; Peters 1996.
[7] Global: Tejada-Flores 1978; B.D. Richters, personal obervation.

Figure 1. Effects of resource use systems on the components and attributes of biodiversity. Reproduced from Redford and Richter 2000.

The primary points we gained from our analyses are that:

- different degrees of human use or alteration result in different negative effects on biodiversity;
- some components and attributes of biodiversity are more sensitive than other components to human use or alteration; and
- only extremely limited use or virtually no alteration will protect all components.

In our daily work we confront the discordance between the view that humans can use biodiversity without causing any harm, and our experience, shared by many of our peers, that this is not possible.

We follow in a long history of those who advocate that all biological entities and their environments have intrinsic value independent of their usefulness to humans. This value applies not just to species, or communities, or ecosystems, but to the complex intertwined web of life that has come to be called biodiversity. In such a value system, the preservation of biodiversity for its own sake, in its entirety and in its component parts, is a legitimate objective in and of itself. Our analysis suggested that biodiversity in its entirety can be conserved only in areas of very limited or no human use. But the vast majority of both the terrestrial and aquatic world have been, and will continue to be, vital sources of resources for the human population. We live in a world of use. But we must accept the undeniable fact that we cannot fully conserve the biodiversity of this planet through compatible or sustainable resource use strategies alone. All comprehensive biodiversity conservation strategies must be rooted in large protected areas in both the terrestrial and the marine realm.

The literature we sampled for our analysis is part of an ever-growing body of evidence that pinpoints the effects of specific human uses on specific components of biodiversity. By incorporating this evidence into an analytical framework, conservation biologists can work to provide critical *a priori* assessments of the biodiversity costs of resource use. Such an approach would also support working with resource harvesters to improve the effectiveness of their harvesting methods to ensure that those components and attributes that *can* be conserved under their use regimes *are* conserved. This should help to achieve a key goal of moving resource production systems towards more ecologically benign practices.

It is time for conservation biologists to overcome their methodological differences and the limitations of their data and unite to provide answers and approaches to one of the major issues confronting humans and the other inhabitants of our world—how to sustain the full diversity of life in a world of use.

Literature cited

Freese, C. 1998. Wild Species as Commodities. Washington, DC: Island Press.

Noss, R. 1990. Indicators for monitoring biodiversity: A hierarchical approach. Conservation Biology 4: 355–364.

Letters

Question emailed from website visitor to esupdate@umich.edu

Hi.... I am a Biology student in Belo Horizonte- Brazil. I need to do some questions about felids conservation, because your information is very important for me and I have worked in a school project about felids conservation. What is the importance of the felids conservation and how can I change the public opinion about its importance? What could happen if most of felids were extincts in North America? Why felids are important? Thank you for your attention....

Answer from* UPDATE *research assistant

The importance of *Felidae* conservation:

- nearly every species and race of the *Felidae* is rare or endangered.
- persecution, both direct and indirect, is the primary cause of declining cat populations.
- only 9% of most species' range is protected.
- protected areas are necessary for cat conservation and given prevailing rates of habitat loss and fragmentation, their importance is increasing with time...
- some things that should be done:

1 establishing new protected areas to conserve important habitat on populations.

2 strengthening the protective intrastructure of threatened areas.

3 generating local community support for maintaining the protected area.

4 taking measures to ensure that protected populations are of variable size. Effort must also be directed toward conserving cats in places used more intensively by people.

The main consequence of the extinction of all the *Felidae* in North America...is that the...balance of life would change. These wild cats eliminate many common pests such as various rodents and bats. Without the cats to feed on these animals, there may be an increase of pests around in households, and who wants that?! :)

Response from student

Hello! Thank you for your e-mail! I presented a seminar about conservation of feline last Tuesday and I got to do a great work. I would like to work with felines when it finishes my graduation in 2001 and I would like to know as I could study and to work with felines in USA, and later return and to work at the Pantanal, where we have many felines needing conservation plans.

"Thank you very much, it is always a pleasure to talk with such kind people!"

Special Series: Habitat Conservation Planning

Where Property Rights and Biodiversity Converge Part II: The Role of Science

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Abstract

This article is the second in a three part series synthesizing independent reviewers' recommendations for improving Habitat Conservation Plans (HCPs). It focuses on the need to ensure that plans provide a net survival benefit for endangered species and the important role for independent science in plan development. Although the objective of the Endangered Species Act (ESA) is the ultimate recovery of imperiled species, HCPs are currently not required to confer a net survival benefit to species, and are therefore often criticized as reducing, albeit marginally, the prospects for survival rather than contributing to biodiversity conservation.

One way to recalibrate HCPs to recovery goals would be to link the regulatory assurances given to the applicant with the quality of a plan's conservation measures such that plans consistent with recovery goals would be afforded a greater level of assurances. The quality of HCPs could also be improved if state-of-the-art knowledge and independent biological expertise were utilized during plan development. The participation of independent scientists can improve the efficacy of the conservation and mitigation strategies used in plans, arbitrate differences in scientific opinion, and increase the level of public trust in the final plan. To fulfill these roles effectively, independent scientists must be involved early and throughout the planning process, not simply as post hoc reviewers. To permit this level of participation, we recommend that the HCP approval agencies, rather than the applicant, serve as the 'gatekeeper' to determine who is involved in plan development. Because participation of independent experts can require substantial logistical and financial support, the Natural Heritage Institute is developing a HCP Resource Center to facilitate scientific participation in these processes.

Introduction

Habitat Conservation Plans (HCPs) have become the primary vehicle for implementing the Endangered Species Act (ESA) on non-Federal land. (For a summary of HCPs, please refer to the first article in this series published in the Nov/Dec 2000 issue of ESU.) Because of their key role, HCPs have come under intense scrutiny from both developers and conservationists. Practicing and academic conservation biologists as well as environmental organizations have conducted numerous independent reviews of HCP policy and plans that identify shortcomings in current practices.

Recommendations to improve HCPs have been distilled from these studies by the Natural Heritage Institute. This article is the second in a three-part series that synthesizes these recommendations. Its main focus is on the importance of setting performance standards for habitat conservation planning that will ensure a net survival benefit for endangered species and give value to incorporating independent science into the development of HCPs.

Habitat Conservation Planning must be calibrated to biologically defensible goals

The recovery standard

We start with the premise that the only defensible biological goal for habitat conservation is species recovery. Otherwise, the ESA is merely a set of procedures for slowing the process of extinction. Thus, contribution to species recovery is the yardstick by which habitat conservation planning will ultimately be measured. Unless they *confer a net survival benefit to the species*, HCPs contribute to the loss of biodiversity rather than its conservation. In this case, the efforts of the US Fish and Wildlife Service and the National Marine Fisheries Service (collectively, "the Services") are akin to running an emergency room in which the patients will never be taken off life support systems.

What constitutes the biological recovery of endangered species, however, is far from straightforward. Although the objectives of ecosystem conservation and species recovery are explicit in the ESA, the means to achieve these goals are not. Judging if a given HCP meets the recovery standard is difficult for a number of reasons. First, recovery planning lags behind conservation planning in that many HCPs are approved before the Services have completed draft recovery plans for the species. Second, recovery planning is impeded by agency budget constraints and by the competing demands for agency resources to list species and designate critical habitat, as well as process the growing numbers of HCPs. Where recovery plans do exist, they are often obsolete for current planning (Sher and Weiner 1997). At best, recovery planning is a single species strategy that lacks the advantages of bioregional conservation. Moreover, recovery planning itself is a highly politicized process wherein biological factors can be compromised by economic and social considerations (Defenders of Wildlife 1998).

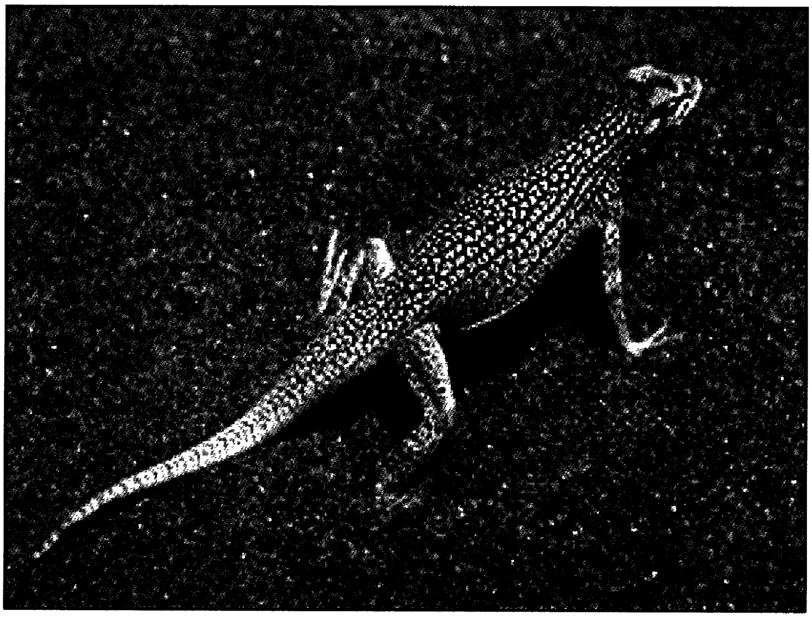

Figure 1. Coachella Valley fringe-toed lizard (*Uma inornata*) was one of the first endangered species covered under an HCP. USFWS file photo/ William R. Radke, Bureau of Land Management.

Notwithstanding these difficulties, the difference between survival and recovery can be understood as posing different risk levels for the protected species. Currently, the acceptable risk level for species is left to the judgment of the applicants and the Services and is seldom made explicit. The data to quantify these risks are often not sufficient; however, qualitative analysis of risk factors is possible. Qualitative risk analysis is familiar terrain in setting air and water quality criteria, for example. Using qualitative assessment, the risk to species can be identified and addressed by looking at the factors that have the largest effect on species' viability. Independent scientific peer review as discussed later in this paper, would be very beneficial in making such qualitative assessments. Where more life history and population data are available, quantitative methods, such as population viability analysis (PVA), can be used to assess relative probabilities of species survival under different scenarios (Beissinger and Westphal 1998).

The HCP approval standard is not necessarily consistent with the statutory recovery goal (Noss et al. 1997). Thus, plans may be approved under Section 10 of the ESA as long they do not appreciably *reduce* the chance of the covered species' survival and recovery, suggesting that some habitat degradation and species loss is acceptable. Certainly, Section 10 does not impose on permittees an obligation to improve the survival prospects for the listed species (Hall 1997). As a result, HCPs can and usually do degrade the *status quo* (Noss et al. 1997).

The approval of HCPs under this standard can only be reconciled with the ultimate objective of recovery and delisting if it is assumed that some other steward of actual or potential habitat will undertake a program to recover the species. This assumption is questionable because federal lands and waters are now also managed to meet a "no-jeopardy" standard, that is, to avoid or mitigate projects that may appreciably contribute to a species' extinction. Moreover, funds to purchase, preserve, and restore high quality habitat are neither a precondition for the approval of HCPs nor are they generally available. The contrast between the HCP approval standard and a recovery standard is best illustrated when an HCP covers most, or all, of the remaining habitat of a listed species. If the majority of this species' range occurs on nonfederal land, recovery cannot occur unless the HCP contributes to that objective (Defenders of Wildlife 1998). The mismatch between biological objectives and statutory requirements is a serious problem for both developers and conservationists because it raises the stakes in the negotiation of HCPs and creates political fault lines that leave both development and conservation interests insecure.

Thus far, Congress has been reluctant to amend the ESA in order to recalibrate the HCP approval criteria to confer a net benefit on listed species. Yet, nothing less will square HCPs with the explicit objective of the ESA, or halt the impending biodiversity crisis. It may be possible to resolve this political impasse if the incremental financial burden of achieving recovery is absorbed by the public rather than imposed on landowners. The costs of avoiding, minimizing, and mitigating adverse impacts on habitat are as much as the developers of non-federal lands and waters are willing to pay in order to meet national biodiversity conservation goals. More to the point, these costs are as much as the political process is willing to impose. The additional measures necessary to bridge the gap between survival and recovery could be undertaken by either the private rights holder through compensation measures, such as conservation easements, or by federal land management agencies, such as habitat restoration on federal lands. In either case, the federal government could absorb the financial burden if both developers and conservationists cooperate to make these measures politically viable.

The remaining issue at hand is whether compensated conservation measures should be voluntary for the private rights holder (as some recent ESA reauthorization bills stipulate), or mandatory at the behest of the Services. This issue is politically controversial because allowing the Services to mandate habitat conservation measures that bear no proportionate nexus to a development project, such as creating preserves, even on a compensated basis, is tantamount to conferring eminent domain authority on the Services. As discussed below, one solution might be to reward private rights holders who accept the mandatory measures deemed necessary to achieve a recovery performance standard with a higher level of regulatory assurances in their HCPs.

Figure 2. An endangered California red-legged frog (*Rana aurora draytoni*). Recent USFWS critical habitat designations in California are integral to species recovery efforts. Photo courtesy H. Brad Shaffer/ Western Amphibian Conservation Group, University of California, Davis.

Incentives to recover species

Creating the right incentives is essential to making the HCP program work. Enforcement of the "take" prohibition under Section 9 of the ESA provides an incentive for private rights holders to seek incidental take permits that require HCPs as a prerequisite (*please refer to the first article in this series*). The practical difficulties in enforcing the take prohibition, however, limit its value as an incentive. For instance, the Services are burdened by their inability to enter private lands without permission and by budget limitations. Also, the data for some species (for example, mussels) are not sufficient to determine what actions constitute a take; for other species, the Services do not know where they occur on private lands. Because the Services have been hesitant to implement the take prohibition, the main incentive for rights holders to develop HCPs today is the fear of citizen suits, and the attendant insulation from prosecution that an HCP can provide. To conclude, enforcement of the take prohibition is clearly an essential incentive for rights holders to develop HCPs, yet it cannot substitute for habitat conservation planning given the current realities.

The ESA does not mandate that HCPs confer a net survival benefit on species; at the same time it does not codify regulatory assurances, such as the "no surprises" guarantee, against additional take restrictions that the Services now issue to permittees. [Under the "no surprises" guarantee, the Services will not require an applicant to provide additional conservation measures or other requirements, beyond those specified in a HCP, regardless of the degree of success or failure of a particular plan.] Since this policy is only an agency regulation, it can be made conditional if the Services find that a HCP provides a net survival benefit to the species for which the guarantee is issued. Also, plans that contribute to recovery might receive assurances for a longer term than those that merely avoid jeopardy. Further, plans based on highly reliable science might be entitled to more extensive guarantees.

In some cases, recovery could be possible without increasing the burdens on private rights holders through shifting a larger share of the conservation costs for a listed species to the federal land management agencies. Yet, today most management decisions on federal land focus on preventing the threat of extinction. This low management standard for public lands should concern the property rights community as much as the conservation community due to a higher burden of species conservation that may be apportioned to the private rights holders if recovery is to be achieved. Of course, holding public lands to a higher standard in habitat conservation will not contribute to the recovery of those species found primarily on private land (see Wilcove et al. 1996 for a discussion of endangered species on private land).

Incorporating independent science and public participation to improve HCP conservation measures

Many performance reviewers agree that HCPs would be improved if state-of-the-art, independent biological expertise was utilized, and if local communities with conservation interests had opportunities to participate in HCP development (Kareiva et al. 1999; Defenders of Wildlife 1998; Anderson and Yaffee 1998). These two recommendations merge under the premise that independent scientific experts are the most effective representatives of the public's interest in improved conservation planning.

In a March 1997 letter to the Clinton Administration and Congress, a number of prominent conservation biologists warned that many HCPs have been developed without adequate scientific guidance in the form of independent peer review. Consequently, these plans contribute to, rather than alleviate, threats to listed species. These scientists recommended that the data, analyses, and interpretations regarding species status, take, impact, mitigation, and monitoring should be reviewed to ensure that HCPs are founded on sound science (Murphy et al. 1997).

Why there is a need for independent science in Habitat Conservation Planning

In the general process of developing an HCP, biologists employed by the applicant submit a plan to the Services, sometimes working informally with the Services biologists in the process (Defenders of Wildlife 1998). Typically, relatively little detailed information concerning a listed species' habitat exists at the time of listing; thus, gathering this information is the first requisite in preparing an adequate HCP (USFWS and NMFS 1996). This process can be labor-intensive and expensive, one reason why it is easier to prepare landholding-specific HCPs after a bioregional conservation plan has already been developed. As HCPs include more species and grow in geographic scope and duration, the complexity of biological planning increases. Larger HCPs often require Herculean efforts in order to assemble and analyze all the relevant ecological information, prioritize habitats and projects, and evaluate management techniques. To meet these considerable demands, those who prepare HCPs generally need to conduct field surveys and utilize state-of-the-art tools for planning (for example, geographic information systems), all of which can greatly increase the costs of HCP development.

Performance reviews reveal that existing plans often do not include sufficient analysis or research to substantiate the conservation strategies. Of particular concern are data omissions regarding the cumulative impacts of development activities elsewhere in the surrounding landscape. The exclusion of data on questions such as the amount and quality of habitat for feeding, breeding, and migration were also judged to be a serious problem in the development of mitigation or minimization efforts (Kareiva et al. 1999). Even when a fair amount of information is known about a species, it is still difficult to incorporate biological data efficiently into conservation strategy decisions because no well-accepted model exists. Yet, all in all, the scientific quality of HCPs, especially in terms of mitigation analysis, has been improving (Kareiva et al. 1999).

The Services, responsible for making sure that applicants use adequate scientific information to develop HCPs, acknowledge that the availability of up-to-date biological information is crucial to any HCP. Yet, the HCP Handbook (USFWS and NMFS 1996) stipulates that data collection is exclusively up to the applicant, as is the threshold decision whether the available biological information is adequate to proceed with planning. According to the handbook, the Services will make recommendations on research and collection of biological information if the applicant conveys to the Services that additional data are needed (USFWS and NMFS 1996). Yet, the applicants have little motivation to activate the Services in this way: their primary concern is for speedy, cost-efficient plan development. Thus, they prefer to avoid resource- and time-intensive studies unless the Services require them for the HCP approval.

Some of the HCP reviews have found that the statutory command to minimize and mitigate project impacts to the maximum extent practicable has caused HCP negotiations to be driven by considerations of economic feasibility rather than principles of conservation biology. As a result, the applicant's assertions regarding the effects of mitigation alternatives on profit margins, as opposed to scientists' assertions regarding biological imperatives, have become operative fact. This trend has led some scientists to criticize HCPs as discretionary measures based mainly on political and economic considerations rather than on empirical scientific data concerning the ecological requirements of a species (Bingham and Noon 1997). The intervention of independent science, however, can give biological principles greater weight in the HCP process.

The role of independent scientists
Apart from the influence of economics and politics, a range of scientific opinion may exist on whether the conservation strategy adopted in an HCP is adequate to meet the stated biological objectives. Establishing an independent scientific review might help to arbitrate the differences in professional judgment and help ensure species survival and recovery. Independent review is also important in fostering public confidence in the HCP process. The concurrence of the broader scientific community confers an *imprimatur* of technical excellence that can garner public acceptance for controversial HCPs.

Under current practice, independent scientists could become involved in the development of HCPs through informal consultation, or by serving on a scientific review panel. When the applicant is a private landowner, such opportunities usually come only after the HCP has been developed and submitted to the Services for approval. Even this limited involvement often arises only at the behest of the outside scientist (or an environmental organization that organizes scientific review), not as a result of solicited peer review. When the applicant is a public agency or political jurisdiction, scientific advisory committees that include representatives from governmental agencies, conservation organizations, consultants, industry, and academia are often formed. The question here becomes whether the plan effectively incorporates the input of the independent scientists who are generally involved later in the process. Their participation, however, is strictly voluntary and not part of a routine practice in the HCP formulation.

Volunteer services, such as *post hoc* peer review of completed plans, are not enough for a successful HCP. Defensible science must be integrated throughout all phases of the planning process. It is important for scientists to compile their own data and do analyses, as opposed to merely reviewing someone else's results. The input must come at the formative stage of the planning process to assure that the reserve design or mitigation strategy will be based on the principles of conservation biology. Such is not the case today as scientific contribution is often given only at the final stage when the Service issues the incidental take permit. For instance, public assessment of completed plans comes at the least useful stage, making the chances for changing major elements of the plan slim. In the current system, late scientific analysis relegates science to the role of an adversarial interest at the approval stage rather than a shaping influence at the foundational stage (Noss et al. 1997).

Access barriers for independent science
Even though state-of-the-art biological information is of pivotal importance, the Services defer to the applicant regarding admission of others to the HCP negotiation process. In the role of "gatekeeper," applicants typically do not wish to involve interested scientists who are neither agency staff nor consultants paid by the applicant. As it is, applicants argue that they spend large sums of money to hire competent consulting firms and that the Services' reviews are already excessive (Hosack et al. 1997).

The Services' deference to the applicants on public participation reflects their view of the HCP as a permit application over which the applicant itself should exercise final, substantive control. Yet for all intents and purposes, a HCP is a negotiated settlement of an applicant's regulatory liability under the ESA. The plan determines the terms and conditions under which a discretionary permit will be issued to engage in otherwise forbidden acts, namely the taking of protected species. Once these terms and conditions are approved by the Services, issuing the incidental take permit or implementation agreement is largely a formality.

Under these circumstances, the HCP development and approval process should be as open to outside scientists and interested public as is the issuance of land-use permits in other contexts. For example, when the Department of Interior grants grazing permits under the Federal Land Policy and Management Act, it allows for public participation in order to accommodate all parties affected by the process. The granting of Clean Water Act permits and local building permits entail similar public processes. Applicants applying for these permits are not allowed to control participation in the issuing process. Likewise the Services, not the applicants, should determine who gets a seat at the HCP negotiation table. Native fish and wildlife are public resources under both state and federal jurisprudence, wherever they may be found. It is fundamentally wrong to treat the permitting process as a private, rather than a public, affair especially when the public does have a legitimate interest in the substantive validity of the negotiated terms and conditions for the take of endangered species on private lands.

The recommendation that the Services, rather than the HCP applicants, act as the gatekeeper of HCP negotiations does not mean that the Services must admit everyone who knocks on the door to the negotiating table. Demonstrated ability to contribute substantively to the issues on the table without undue delay could be the price of admission. Qualified conservation biologists should have an easier time crossing that threshold than would lay representatives of the public interest. The Natural Heritage Institute has urged the Services to assume the role of making these decisions instead of leaving them to the permit applicant who has a vested interest in moving the negotiation process forward with the least resistance.

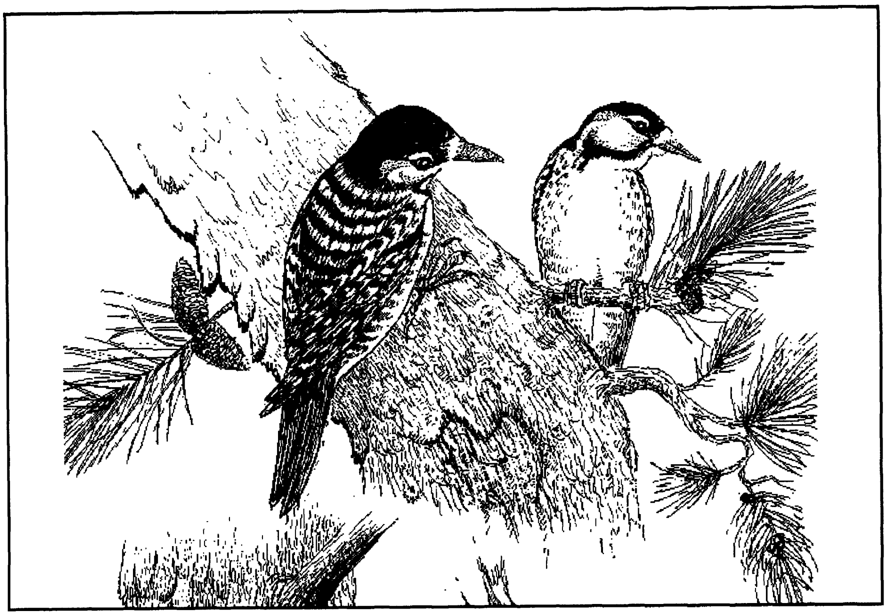

Figure 3. Red-cockaded woodpeckers (*Picoides borealis*). Line drawing courtesy Robert Savannah, U.S. Fish and Wildlife Service.

The value of public participation in Habitat Conservation Planning

It must be recognized that the public does have a significant stake in the HCP process because wildlife is a public resource, both legally and in the court of public opinion. Further, the conservation responsibilities or risks that are not shouldered by the HCP applicant will either be borne by the species, shifted to other landowners, or transferred to the public lands (the latter usually at public expense). For instance, an HCP authorizing land disturbances that can cause flooding, mudslides, or loss of fisheries directly affects the welfare of the local community (Kostyack 1997). Thus, public participation in the development of an HCP can enhance the quality of information on which HCP decisions are based, improve understanding and relationships among stakeholders, heighten public and political support for an HCP, and enhance the plan's long-term viability. Indeed, the extent to which the public accepts an HCP is strongly related to the degree of public participation in the plan's development. The larger the role that interested parties are accorded in developing conservation plans, beyond simply commenting on completed plans, the more satisfied they tend to be with the final result (Anderson and Yaffee 1998).

When a county or state agency applies for federal approval of a HCP and then issues development permits, the local community and general public have easier access to the process, thereby diminishing the issue of participation. Also, HCPs that include some form of public land—federal, state, or local—tend to encompass wider public participation than HCPs that strictly involve private land. The public usually becomes involved earlier and more actively in HCPs on public land compared to those on private land (Anderson and Yaffee 1998).

Public participation, however, is usually extremely limited when private rights holders initiate the HCP process, a tendency exacerbated by the Services' insufficient guidance on fostering public participation. Following HCP guidelines, the Services merely encourage applicants to involve appropriate parties and hold informational meetings during public comment periods (USFWS and NMFS 1996). The Services have taken a "satisfied customer" approach to HCPs wherein they view the applicant rather than the public as the "customer" to satisfy (Anderson and Yaffee 1998).

Public participation under the National Environmental Policy Act

Issuance of an incidental take permit is a federal action subject to the National Environmental Policy Act (NEPA). Like the NEPA, the ESA requires a description of alternative actions to such taking of a species. But, the NEPA goes beyond Section 10 of the ESA in considering the comprehensive impacts of a federal action on the natural environment and not just the impacts on wildlife resources. To satisfy the ESA requirement, applicants commonly analyze just two alternatives; however, they must explain why an alternative was rejected. The Services do not have the authority to impose a choice among the alternatives analyzed in a particular HCP; their role during development is to simply advise the applicant in developing an acceptable plan (USFWS and NMFS 1996).

NEPA's comment periods and disclosure requirements often provide the only opportunity for the interested public to review and comment on an HCP before it is approved. NEPA's usefulness as a participation and communications device, however, is limited because the HCP negotiations tend to solidify a particular approach before they can be influenced by public environmental review (Anderson and Yaffee 1998). Similar to any planning effort, the HCP process becomes less flexible as time goes on and more ground is covered. Therefore, effective public involvement requires access to the decision-making process before major decision have been negotiated and incorporated into a draft impact statement. Based on these considerations, performance reviewers have recommended that the Services implement "trigger points," or points between scoping and the comment period, when negotiators would be required to disclose agreements in early drafts and seek public comments on those documents (Anderson and Yaffee 1998).

Tools for facilitating effective participation by independent scientists and local communities

National databank for HCP materials

In order to facilitate public involvement in HCP preparation, several experts have recommended that the Services maintain a comprehensive, publicly accessible databank of HCPs (Lin 1996; Anderson and Yaffee 1998; Kareiva et al. 1999). The databank should include sufficient details to assist landowners in matching their conditions to previously approved HCPs. This characteristic would allow applicants to model their plans after the successful efforts of others. It would also allow the public and nonprofit conservation organizations to track and monitor the implementation of the ESA through individual HCPs. The public is currently not able to follow this implementation as closely as some would like (Kostyack 1997) as no central repository of completed plans and no log of HCPs under development exists. Today, information on individual plans can only be found by calling government field offices and asking overworked biologists. This databank would help both the public and Services track the overall performance of approved plans (Kareiva et al. 1999). The financial cost of maintaining such a databank would be relatively modest since it would utilize information already compiled by the Services.

The HCP Resource Center

Local communities and conservation organizations that are interested in upgrading the scientific competence of HCPs generally do not have access to the requisite expertise or have the means to procure it. To meet this obvious need, the Natural Heritage Institute is working with other national conservation organizations to create a pool of resources, both intellectual and financial, that will facilitate independent scientific expertise in HCP negotiations on behalf of conservation interests and local communities. The HCP Resource Center will consist of a nationwide network of conservation scientists from universities, private consulting organizations, and the non-profit sphere who represent the full range of relevant sub-specialties. It may also include resource economists and wildlife law experts with appropriate negotiation skills. Teams specializing on the fundamentals of a particular HCP will be assembled to engage directly and effectively with the Services and the applicant's team of scientists and negotiators. Creation of the HCP Resource Center is currently in the planning and fundraising stages. Establishing the center will be a resource-intensive process: high quality, independent science comes with a price tag and, for most species, qualified experts are not numerous.

Conclusion

The expressed goal of the Endangered Species Act—and the only defensible biological goal for habitat conservation planning—is the recovery of listed species. Unless HCPs *confer a net benefit to species' viability*, plans will contribute to the loss of biodiversity rather than its conservation. Nonetheless, the ESA authorizes approval of HCPs that reduce the prospects for species' survival and recovery provided that the reduction is judged to be not "appreciable." Potentially, HCP proponents can be induced to adopt biological goals that go beyond the minimum legal standard by rewarding those plans that contribute to a net benefit for species with a higher level of regulatory assurances.

The quality of HCPs can also be improved by expanding participation in plan development, particularly from independent scientific experts. Independent scientific review can help ensure that plans adequately incorporate principles of conservation biology, and deal transparently and forthrightly with the uncertainties associated with complex and dynamic biophysical systems. Independent review is also key in fostering public confidence in the HCP process. It is important that scientists contribute substantively to decisions, and not simply review a plan after the major decisions on conservation strategy and mitigation measures have already been negotiated. Therefore, we recommend that independent experts be involved in HCPs in an early, ongoing, and substantive manner. Currently, this quality and degree of participation is rare in plans prepared by private rights holders because the Services allow the applicant to control access to the process. The Services could foster greater participation of scientific experts by serving as the "gatekeeper" overseeing participation. Because the participation of independent experts can require substantial logistical and financial support, the Natural Heritage Institute is developing a HCP Resource Center to facilitate scientific participation in HCP processes.

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Marine Matters

A Review of Marine Major Ecological Disturbances

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Abstract

The apparent increase in marine morbidity and mass mortality events, the emergence of new diseases across a range of taxa, increases in harmful algal blooms, and the longterm and often unexplained declines of various wildlife populations have heightened concern and debate over human impacts on the marine environment. Resolving the relative extent to which natural and anthropogenic factors drive marine major disturbance events is becoming increasingly important as public health, economic activity, and biodiversity are threatened along various coastal regions. Understanding environmental change within the context of highly complex systems has proven to be difficult, and thus increased scientific focus on large-scale marine disturbances along with more precautionary approaches in managing human activity are warranted.

Concern has mounted over the last 15 to 20 years over what appears to be an increase in the number and scale of disturbances affecting marine species and populations (Harvell et al. 1999; Williams and Bunkley-Williams 2000). The term "marine major ecological disturbance," or MMED, has been coined (Williams and Bunkley-Williams 1990) to loosely describe events occurring over at least a regional scale, are the result of multiple factors, and are characterized by an unusual increase in a syndrome or disease, or in mortality rates. In this brief, we also consider emerging diseases and unprecedented (and often unexplained) population declines as major disturbances. Algal blooms, though natural phenomena, are also included because of the recent increase in their frequency, intensity and geographic distribution and, hence, their growing role in marine morbidity and mortality events.

Marine-based mass mortalities—notably of fish and invertebrates—are not without precedent and have been commonly noted and recorded in the past. Brongersma-Sanders (1957) compiled an exhaustive review of marine wildlife "catastrophes" and categorized the causes as vulcanism (volcanic activity), tectonic earth- and seaquake, change in salinity, temperature change, noxious waterbloom, lack of oxygen, and by poisonous gases, severe storms, as connected with spawning runs, by stranding, or uncertain. The impacts of marine disturbances can be profound. Populations of plant and animal species can be substantially reduced across large geographic regions, and there can be collateral and extended effects on other species and surrounding environments. During the early 1930s, a "wasting disease" caused by a pathogenic strain of slimemold (*Labyrinthula* spp.) virtually exterminated eelgrass (*Zostera marina*) throughout its north Atlantic range (Short et al. 1987) and resulted in the extinction of the eelgrass limpet (*Lottia alveus alveus*) (Carlton 1993), a 75 to 90 percent decline in dark-bellied brent geese (*Branta bernicla bernicla*), and as much as a 90 percent decline in Atlantic brant (*B. b. hrota*) (Ganter 2000). Long-spined sea urchin (*Diadema antillarum*) were virtually eliminated (approximately 95 percent mortality) throughout much of the Caribbean during 1983 and 1984 (Lessios 1988) in what was the most extensive disease event ever recorded for a marine invertebrate. Thick mats of macroalgae overgrew many reefs in the absence of the grazing sea urchins though other factors, natural and anthropogenic, have combined to cause the decline of Caribbean coral reefs over the last decades (Hughes and Connell 1999).

Recent mass mortality episodes involving Mediterranean monk seals (*Monachus monachus*) and Hooker sea lions (*Phocarctos hookeri*) highlight the potential impact of MMEDs on endangered species. This would suggest a significant vulnerability to various marine species in the U.S. such as the north Atlantic right whale (*Eubalaena glacialis*), the Hawaiian monk seal (*Monachus schauinslandi*) and the Florida manatee (*Trichechus manatus latirostris*), all of which are still impacted by human activity (Marine Mammal Commission 2000a). On the other hand, Fiori and Cazzaniga (1999) consider that the yellow clam (*Mesodesma mactroides*) had become a threatened species under IUCN criteria following mysterious mass mortalities across its entire range (southern Brazil to the Negro River in Argentina). In the U.S., disturbances in the Bering Sea/Alaska region have recently prompted ESA listing, or petitions, for four species. Unique environments may also be threatened: Williams et al. (1999) have predicted the disappearance of Atlantic coral cay ramparts, structural habitat formed in large part by elkhorn coral (*A. palmata*) rubble. They hypothesize that the large reduction in elkhorn coral by major disturbances—disease and bleaching—are reducing the material required for rampart replenishment and thus making existing structures highly susceptible to storm action.

However, while north Atlantic eelgrass recovery has been slow, and it is unlikely that sea urchins will ever rebound to past abundances in the Caribbean, many mass mortality events are ephemeral. Herring (*Clupea harengus*) populations in the Gulf of St. Lawrence recover quickly after severe epizootics involving the fungus *Ichthyophonus hoferi*, an event that occurs at roughly quarter century intervals (Sindermann 1958). Fish and benthic communities suffering massive mortalities during an unprecedented *Chrysochromulina polylepis* bloom covering approximately 75,000 km^2 of Scandinavian waters in 1988, were found to have generally recovered within five years (Gjosaeter et al. 2000).

A variety of events have underlined the perception that MMEDs have increased over recent years. Some of the more significant of these include:

Marine mammal mass mortalities
Morbilliviruses have emerged as an important factor in marine mammal epizootics and were implicated in mass mortalities involving bottlenose dolphins (*Tursiops truncatus*) along the U.S. Atlantic coast (1987 to 1988) and Gulf of Mexico (1993 to 1994), harbor seals (*Phoca vitulina*) in the North Sea (1988), striped dolphins (*Stenella coeruleoalba*) in the Mediterranean Sea (1990 to 1992) and common dolphins (*Delphinus delphis*) in the

Table 1. Selected disturbances in Florida marine fauna and flora, 1980 to present.

Year	Species	Disturbance
ongoing	sea turtles	Indian River Lagoon, Florida Bay, Florida Keys: high prevalences of fibropapilloma disease; ongoing since its epizootic emergence in the mid-1980s; causes are unknown (Jacobson et al. 1991; Lackovich et al. 1999; Landsberg et al. 1999)
2000-01	loggerhead turtle	Indian River to Charlotte Counties: between September (2000) and February 7 (2001), 150 sick or dead turtles have been reported; because most sea turtles do not wash ashore many more are expected to have died; unique disease conditions in afflicted animals though cause(s) are unknown (Florida Marine Research Institute 2001)
2001	bottlenose dolphin	Indian River Lagoon: increase in skin lesions; severe dermatitis and lobomycosis noted in five animals (Bossart pers comm)
2000-current	manatee	Homosassa Springs: papilloma virus lesions in isolated population; first discovery of a virus in manatee (Kirley 2000)
2000	bottlenose dolphin	Atlantic coast: oral papillomas in 12 animals (Bossart pers comm)
2000	bottlenose dolphin	Florida Keys: 150 animals stranded, with at least 31 mortalities, over a two day period in mid-January; causes are unknown (Marine Mammal Commission in prep)
1999-current	seagrass	Barnes Key, southeast Florida: scattered patches of diseased seagrasses resembling conditions associated with massive mortalities in late 1980s and early 1990s (Durako, pers comm)
1999-2000	bottlenose dolphin	Florida panhandle: 68 dead animals found between August 8 and October 31; by February 2000 total strandings numbered approximately 120; brevetoxin suspected (Hull 2000; Marine Mammal Commission in prep)
1996	manatee	Southwest Florida: over 150 animals are killed by brevetoxin intoxication (Bossart et al 1998)
1995	coral	Alligator Reef: first recorded occurrence of "white plague type II" disease; the disease ultimately infected 17 species of scleractinian corals over ~200 km along the Florida Keys (Feingold & Richardson 1999; Richardson et al. 1998)
1994-96	dolphins	South Florida: immunoblastic malignant lymphoma (cancer) noted in five animals (Bossart et al. 1997)
1994	coral	Florida Keys: first identification of "yellow-blotch" disease (originally called "yellow-band" disease); disease incidence and associated coral death has increased in some areas since (Green & Bruckner 2000; Reeves 1994)
1993-94	reef fish	Palm Beach/upper Florida keys: mass mortality (est. at several thousands) over a 3 month period; multiple pathogens found, but no one primary suggesting that some stressor severely weakened the fish; 1st extensive reef-fish mortality event reported in Florida since 1980 (Landsberg 1995)
1992-93	sponges	Florida Bay: further mass mortalities of sponges coinciding with cyanobacteria blooms (Butler et al. 1995)
1991-92	sponges	Florida Bay: mortality of over 80% of vase, candle and commercial sponges and over 40% of loggerhead sponges in an area covering hundreds of km^2 and coinciding with unprecedented blooms of cyanobacteria (Butler et al. 1995)
1991	sea urchin	Lower Florida Keys: suspected disease event reduced densities by 97% (Forcucci 1994)
1989-1992	fish	North Biscayne Bay: two studies note high levels of developmental abnormalities across a range of fish species suggesting one common stressing agent; cause is not determined (Browder et al. 1993; Gassman et al. 1994)
1987-88	bottlenose dolphin	Atlantic coast: major mass mortality event involving the deaths of ~2,000 animals from Florida to New Jersey (following a migration trajectory); likely morbillivirus-related though environmental contaminants and brevetoxin may have contributed to the severity of the event (Geraci et al. 1999)
1987-1991	turtle grass	Florida Bay: unprecedented mass mortality event that ultimately destroys 4,000 ha of *Thalassia* seagrass beds while affecting another 23,000 ha; a complex etiology suspected (Robblee et al. 1991)
1983	common loon	Florida Gulf and Atlantic coasts: over 13,000 wintering loons may have died over a three month period; a complex etiology was suspected (Forrester et al. 1997)
1982	manatee	southwestern Florida: 37 animals killed likely via brevetoxin ingestion during a red tide bloom; deaths of cormorants and fish also reported (O'Shea et al. 1991)
1982	bottlenose dolphin	Indian River/Banana River: ~50 animals found dead in a three month period; likely caused by a morbillivirus (Duignan et al. 1996)

Black Sea (1994) (Birkun et al. 1999; Geraci et al. 1999; Lipscomb et al. 1994; Taubenberger et al. 1996).

Over the same period, algal toxins have also been increasingly correlated with mortalities. Geraci et al. (1989) considered saxitoxin vectored by mackerel (*Scomber scombrus*) as the cause of 14 humpback whale (*Megaptera novaeangliae*) mortalities in the Cape Cod Bay area during late 1988 and early 1989. A die-off of highly endangered Mediterranean monk seals in 1997 off the western Sahara coast, which reduced that population by over 50 percent, was also attributed to saxitoxin (Costas and Lopez-Rodas 1998) though this is controversial; others (e.g., van de Bildt et al. 1999) have emphasized a morbillivirus as the cause (though see Harwood (1998) for a multifactorial explanation). Brevetoxin, produced by the dinoflagellate *Gymnodinium breve*, killed approximately 150 Florida manatee, another endangered species, in 1996 (Bossart et al 1998), and was likely the cause for a smaller die-off in 1982 (O'Shea et al. 1991). *G. breve* blooms have also been associated with recent bottlenose dolphin mortalities in the Gulf of Mexico (Marine Mammal Commission 2000 in prep) though given the frequent overlap of living dolphins and red tides in this region it remains perplexing why so few mortality events are reported. In 1998, domoic acid associated with a bloom of the diatom *Pseudo-nitzschia australis* killed over 400 California sea lions (*Zalophus californianus*) along the central California coast over a short period in 1998 (Scholin et al. 2000). High numbers of sea lion strandings during the latter half of 2000, and in the same general region, appear also to have been domoic acid related (Marine Mammal Commission in prep).

At least 1,600 Hooker sea lions perished in a mysterious mass mortality event in the Aukland Islands during early 1998 (MUCIC 1998); this species' range and abundance is vastly reduced from historical times and numbered some 12,500 animals prior to the event (Gales and Fletcher 1999). Two separate mortality events involving a number of marine mammal species occured during the early 1990s in the Gulf of California; algal toxins were deemed the likely cause (Ochoa et al. 1997) but no supporting information was made available. In addition, gray whales (*Eschrichtius robustus*) have succumbed in high numbers along their migratory route from Mexico to Alaska during both 1999 and 2000; 273 and 355 animals were found respectively (Marine Mammal Commission in prep). During the previous ten years, the highest number of strandings reported for any one year was 87. Le Boeuf et al. (2000) have argued that malnourishment was the likely factor based on the discovery of a number of emaciated animals and have postulated that this could have been due to climate-related declines of their principal prey of benthic amphipods or to the whales having surpassed their carrying capacity. This conclusion, however, may be premature as many of the other stranded animals were reported as appearing in good nutritional condition (Marine Mammal Commission in prep).

Coral disturbances

It has been well documented (Jameson et al 1995) that many of the world's tropical coral reefs have been in decline or have been destroyed over the last decades—typically the result of fisheries, land-use changes increasing sedimentation, and nutrient pollution. While these are considered the most important and immediate threats to reefs, coral bleaching and disease have emerged as large-scale disturbances that would seem to portend an acceleration of coral decline.

Coral bleaching, which results from the loss of the endosymbiotic algae that reside in the cells of the coral host, is a generalized stress response and if prolonged will lead to a decrease in growth and reproduction; extended bleaching will eventually result in the death of entire colonies (Glynn 1996). Prior to the 1980s, bleaching other than on local scales appears to have been extremely rare. Since then the frequency of bleaching has increased substantially (Williams and Bunkley-Williams 1990) with impacts having expanded to regional and global scales. Six bleaching events affecting corals worldwide have occurred since 1980, with the 1998 mass bleaching event considered the most extensive and severe on record (Hoegh-Guldberg 2000). An estimated 16 percent of global coral was killed with highest mortalities occurring in the Middle East and wider Indian Ocean (Wilkinson 2000). 1998 was also characterized by the highest sea surface temperatures ever recorded (Hansen et al. 1999). It is now considered (e.g., ISRS 1998) that the most probable cause of the overall bleaching increase has been the rise of global temperature and associated meteorological extremes.

Increases in reports of coral diseases, including potential disease states and syndromes, generally parallel the rise of bleaching events though any causal connections between the two are obscure. The first three diseases to be reported in coral—black and white band disease and white plague—were not described until the 1970s (Richardson 1998), and highly destructive effects were only first noted during the early 1980s with the recognition that structurally-important acroporid corals were being eliminated by white band disease throughout areas of the Caribbean (Gladfelter 1982). Twenty-six additional "diseases" have been reported in the literature since then (Green and Bruckner 2000) though not without some confusion: different names may have been given to different stages of the same disease; and it is unclear in many cases that what has been described is actually a disease (Hayes and Goreau 1998; Richardson 1998).

A soil fungus, *Aspergillus sydowii*, however, was clearly determined as the pathogen behind a major epizootic involving sea fan corals which has been ongoing throughout the Caribbean since the mid-1990s (Geiser et al. 1998)—and similar disease symptoms suggest that it was the likely factor in mass mortalities of the species during the early 1980s. *A. sydowii* spores have been isolated from dust atmospherically transported from Africa and were successfully innoculated in healthy sea fans (Weir et al. 2000 as cited in Shinn et al. 2000); the "dust hypothesis" has now been added to the large number of potential factors involved in the gradual demise of Caribbean reefs (Shinn et al. 2000). The unprecedented nature of some recent coral disturbance events has been demonstrated in cores extracted from Belizean reefs: two recent mass mortality events—involving staghorn coral (*Acropora cervicornis*) and white band disease in the late 1980s, and lettuce coral (*Agaricia tenuifolia*) during the 1998 bleaching complex—have had no historical equivalent there in a record extending back 3,000 years (Aronson et al. 2000).

Harmful algal blooms

Numerous recent reports and reviews (e.g., Morand et al. 1996; Smayda, 1990) have provided compelling evidence for an increase in the frequency, intensity, duration, and geographic distribution of seaweed and phytoplankton blooms, and toxicity events. Previously benign or unknown species have emerged as problematic (Burkholder et al. 1992; Ito et al. 2000; Todd 1993) and there has been a concomitant increase in reports of associated disruptions on flora and fauna, human health, tourism, aquaculture, and on recreational and commercial fisheries (Burkholder 1998; Van Dolah 2000). Yet the magnitude of human influence still remains largely unclear and increased reporting of such events would be expected given rapidly growing coastal populations and increased human exposure (e.g., via shellfish consumption), and the considerable expansion in surveillance programs and scientific attention. Likewise, the explosive growth in coastal finfish aquaculture may have promoted localized blooms by nutrient enrichment or by providing visible targets for bloom effects, or both. Definitively quantifying any increase is further prevented by the absence of data sets long enough to factor out cyclical fluxes and climate variability. The balance of evidence, nonetheless, suggests that human influence via nutrient enrichment and eutrophication, alteration of nutrient ratios, and by shipping- and aquaculture-mediated introductions has been a critical factor.

Sea turtle fibropapilloma disease

Though originally described in the late 1930s in green sea turtles (*Chelonia mydas*) in the Florida Keys, the conspicuous external tumors associated with fibropapilloma disease were anecdotally noted in this species in Florida around 1900 (Jacobson et al. 1991), and noticed for the first time in Hawaii in 1958 (Balazs 1991). It appears to have been quite rare until the late 1970s before its expansion into epizootic proportions in green turtles at multiple sites in those two states—in 52 percent (70 out of 134) of strandings in the Florida Keys between 1983 and 1989 (Jacobson et al. 1991), a prevalence of 72.5 percent (121 out of 167); in the Indian River Lagoon in 1998 (Lackovich et al. 1999); and a prevalence of 44.9 percent (n=581) from a capture and tagging program in Kaneohe Bay in Hawaii between 1989 and 1997 (Balazs et al. in press). Other areas, even with minimal geographic separation from affected populations, have remained virtually free of the disease. Since 1985 fibropapillomas have been reported in green turtles from Australia (Limpus & Miller 1994) and from fourteen Caribbean countries (Williams et al. 1994), with a considerable increase in Puerto Rico and Columbia. The disease appears to have recently emerged in loggerhead turtles (*Caretta caretta*) with prevalences of up to 11 percent in Florida Bay (Landsberg et al. 1999), and has been reported in prevalences of 1 to 10 percent in the large population of olive ridley turtles (*Lepidochelys olivacea*) nesting at Ostional on the Pacific coast of Costa Rica (Aguirre et al 1999).

Sea turtle fibropapilloma disease can severely debilitate afflicted animals causing stranding and death, though in some cases tumors remain minimal or can regress (Herbst 1994). A herpes virus and retrovirus have been identified in association with the disease (Casey et al. 1997; Herbst 1994) but the primary cause and modes of transmission are unknown. Landsberg et al. (1999) have suggested the possible role of okadaic acid, a tumor promoter associated with the toxic benthic dinoflagellates *Prorocentrum* spp., and epiphytic on forage plants.

Disturbances in U.S. coastal waters

The Health Ecological and Economic Dimensions (HEED) of Global Change Program, in a review of marine disturbances from the U.S. Atlantic and Gulf coasts and the Caribbean (1945 to 1996), concluded that anomalous morbidity and mortality events had increased since the early 1970s (Epstein et al. 1998; Sherman 2000). Recent events in Florida coastal waters (Table 1) are representative of the range and types of disturbances currently being reported for the wider Caribbean (see Williams et al. 2000), and suggest a larger regional phenomena. The increase in coral disease and reef decline has been particularly noticeable. In extensive surveys (160 monitoring stations) throughout the Florida Keys, Porter et al. (1999) and Jaap et al. (2000) documented increases in areas with disease (from 26 stations in 1996 to 131 in 1998) and in numbers of species affected (from 11 species in 1996 to 31 in 1998). Furthermore, 67 percent of the monitoring stations lost species between 1996 and 2000, and stony coral cover decreased by about 40 percent between 1996 and 1999. Some 75 percent of all Florida Key coral species now present disease symptoms but the question of why so many have become simultaneously susceptible to a variety of pathogens has yet to be answered (Porter et al. 1999).

The preponderance of microalgal involvement in disturbance events in U.S. Atlantic and Gulf waters was also noted by the HEED program and, indeed, a recent review (CENR 2000) concluded that the effects of harmful algal blooms in the U.S. have expanded from a few scattered coastal areas to virtually all coastal states over the past two decades. However, the report noted that the relative roles of increased observer coverage and monitoring, nutrient enrichment, the introduction of exotic species, and naturally-mediated range expansion remain unresolved. The increase in algal blooms globally has occurred in tandem with increases in cultural eutrophication (Smayda 1989; Paerl 1997), a pattern readily evident in U.S. estuaries (Bricker et al. 1999). The recent emergence of predatory and toxic *Pfiesteria*-like dinoflagellates as a conspicuous feature of massive fish kills (10^3 to 10^9) in mid-Atlantic estuaries has been linked, in part, to nutrient enrichment (Burkholder and Glasgow 1997).

A relationship between the toxic effects of *Pfiesteria* spp. and recent and recurring epidemics of a severe ulcerative disease (ulcerative mycosis) in U.S. southeastern finfish, primarily menhaden (*Brevoortia tyrannus*), has been proposed (Burkholder and Glasgow 1997; Noga et al. 1996) but has also underlined the complexities of marine pathobiology (see Blazer et al. 1999). The most important feature of diseased fish has been the involvement of the fungal-like organism *Aphanomyces* spp. but difficulties in fulfilling Koch's postulates with either *Pfiesteria* or *Aphanomyces* would suggest that other factors are involved (Dykstra and Kane 2000). Other U.S. marine disturbances have also presented a considerable challenge. Hundreds of thousands of lobsters (*Homarus americanus*) were estimated to have died in an apparent disease-related event in Long Island Sound over the latter part of 1999. A paramoeba infection is suspected but the predisposing factors are unknown (Van Patten and French 2000). Withering disease has virtually exterminated black abalone (*Haliotis cracherodii*) from the Channel Islands since emerging during the mid-1980s, and has since spread to populations on the mainland California coast (Altstatt et al. 1996). The pathogen, a rickettsiale, has only recently been confirmed (Friedman 2000) but the factors prompting the emergence of the disease are unknown; its severity, however, is enhanced by increased water temperature (Moore et al. 2000).

Some of the most profound disturbances associated with marine wildlife populations have been ongoing over the past decades in the Alaska region. Northern fur seal (*Callorhinus ursinus*) numbers fell from 1.25 million in 1974 to 877,000 in 1983, though they have climbed slightly since then to an estimated 1 million, about 50 percent of pre-exploitation size (NMFSa 1999). Steep declines in harbor seal (*Phoca vitulina richardsi*) numbers were recorded during the 1980s, primarily from the Gulf of Alaska; current overall population size is placed at around 80,000 animals, substantially less than the 270,000 estimated for the early 1970s (Marine Mammal Commission 1998; NMFS 1998). The western stock of Steller sea lions (*Eumetopias jubatus*) numbered approximately 140,000 in the late 1950s and 30,500 by 1990 when it was designated as an endangered species under the ESA. Numbers have continued to decline and were estimated as slightly over 20,000 in 1998 (NMFS 1999b). Sea otters

(*Enhydra lutris*) in the Aleutian Islands have declined from an estimated 55,100 to 73,700 animals in the mid-1980s to under 10,000 by 2000, and have been listed as a candidate species for listing under the ESA (Federal Register 2000). Estes et al. (1998) consider that increased orca (*Orcinus orca*) predation has driven the sea otter collapse, a response to vastly reduced numbers of the orca's preferred prey, Steller sea lions and harbor seals. It has been generally considered (e.g., NRC 1996) that the most important factors involved overall are some combination of a natural climate regime shift and fisheries, and perhaps the effects of prior intensive whaling; their effects may have combined to reduce the abundances of nutritionally-adequate forage fishes.

Occurring in tandem have been declines in various populations of Alaska sea ducks including, for example: (1) a 54 percent decline between 1976 and 1994 of nesting common eider (*Somateria mollissima*) in northern Alaska and the western Canadian arctic; (2) a 2.2 percent annual decline between 1977 and 1998 in black scoter (*Melanitta nigra*) in western Alaska; (3) a 5.5 percent annual decline of oldsquaw (*Clangula hyemalis*) in surveyed areas in western Alaska since 1977; (4) over a 90 percent decline in spectacled eider (*Somateria fischeri*) in the YK-Delta from the 1970s to 1992; and (5) the virtual disappearance of Steller's eiders (*Polysticta stelleri*) from the YK-Delta since initial surveys in the 1960s (USFWS 1999). Spectacled eiders and the Alaska breeding population of Steller's eiders have been listed as threatened under the ESA. There is, however, little consistency in Alaska sea duck trends: some species have generally remained stable or have increased slightly, and species whose populations have declined in one (or more) area(s) have remained stable or have increased in others. Causes of declines are not known.

Anthropogenic and natural influences

It has only been recently (e.g., Sarokin and Schulkin 1992; Rosenberg et al. 1988; Williams and Bunkley-Williams 1990) that human involvement—for example chemical pollution, nutrient enrichment, and climate change—has been deemed a factor to consider when investigating marine disturbances. In addition, it has been increasingly noticed that disease, biotoxins, and food shortages are important components of some disturbance events (Alaska Sea Grant 1993; Harvell et al. 1999). In most instances, however, little can be said over the relative roles of natural processes and human influence as interactions are complex and cover a spectrum of physical, biological and chemical variables. Levels and causes of disease in marine species and the role of disease in regulating populations are, likewise, poorly understood.

Some associations between marine disturbances and climate have been reviewed by Harvell et al. (1999). Lavigne and Schmitz (1990) also suggested that rising temperatures associated with anthropogenic climate change could increase epizootics in pinnipeds, particularly in those species that "haul out" at small temperature increases. Higher densities of seals for longer duration could create the conditions appropriate for pathogen invasion. Increased sea water temperature was correlated with a major epizootic involving commercial sponges (*Spongia* spp., *Hippospongia* spp.) in the Mediterranean Sea between 1986 and 1990 that decimated populations (above 40 m depth) throughout the eastern part of the basin (Vacelet et al. 1994). The event, likely bacterial-related, was unprecedented in Mediterranean recorded history. Millions of sea fans (*Paramuricea clavata, Eunicella* spp.) were estimated to have died in the Ligurian Sea in 1999 in a catastrophic event also correlated with an increase in sea water temperature (Cerrano et al. 2000). Temperature increase was suggested (Vincente 1989) as a possible factor in the extinction of commercial sponges (the same genera as affected in the Mediterranean), in areas throughout the West Indies by the 1950s. Echinoderm mass mortalities in Japan and the Gulf of California were linked to abnormally warm sea water temperature (Dugan et al. 1982; Tsuchiya et al. 1987). Cook et al (1998) noticed a correlation with increasing sea surface temperature and the northward spreading of the protozoan *Perkinsus marinus*, a serious pathogen of the eastern oyster (*Crassostrea virginica*).

P. marinus, however, was likely introduced into the U.S. Atlantic and Gulf coasts via aquaculture—an activity which has been the source of many epizootics (see Renault 1996 for a review). A virus, possibly introduced via baitfish for offshore fish farming, is suspected in two massive pilchard (*Sardinops sagax neopilchardus*) die-offs in Australian waters (1995, 1998 to 99) (Gaughan et al. 2000); in the latter event it was estimated that 60 to 70 percent of total pilchard numbers around western Australia perished. Ballast water dumping practices (Ruiz et al. 2000) and tourism (e.g., Gardner et al. 1997) may also be important sources in the continuing transfer of new microbial pathogens into marine wildlife.

Environmental pollutants, notably the halogenated hydrocarbons have, likewise, been implicated in a variety of marine disturbances (for recent reviews see Oberdorster and Cheek 2000; Vos et al. 2000). Pinnipeds and coastal odontocetes have received particular attention given their high contaminant loading and the recent occurrence of population disturbances that have involved disease or declines in reproductive ability, or both (Marine Mammal Commission 1999).

Polychlorinated biphenyl (PCB) contamination of the resident Puget Sound population of orca may be an important factor in their recent decline (Ross et al. 2000); the population has fallen by 14 percent (from 99 to 84) since 1995 (Forney et al. 2000). PCB levels from live-sampled animals exceed those found to induce immunosuppression and endocrine disruption in harbor seals, though the toxicological significance in orca is not known. Levels of PCBs, DDT, and tributyltin in California southern sea otters are higher in animals dying of infectious disease than from trauma or unknown causes (Kannan et al. 1998; Nakata et al. 1998), and an unusual frequency and variety of diseases in the species have been reported (Thomas et al 1998). The role of contaminants, or disease, in this population's recent decline (Marine Mammal Commission 2000a), however, are likewise not known. Similarly, the impact of environmental pollutants in disease-mediated mass mortality events is not known; however, elevated levels in affected populations (e.g., Kannan et al. 1997; Kuehl et al. 1994) may increase the severity of epizootics through immunosuppressive action (Marine Mammal Commssion 1999).

MMEDs are multifaceted and complex, and teasing out ultimate causes and effects, and the full range of risk factors, has proven elusive in the majority of events (see for example Simmonds and Mayer 1997; Ferguson et al. (2000) for recent case reviews). There is, however, increasing recognition that human activities are now inextricably bound with global processes, and that rapid and unpredicted environmental responses (Streets and Glantz 2000) can ensue from even minor shifts in forcing conditions or from gradual change over extended time periods. Interactions and feedbacks, and the cascades of effects associated with threshold responses, are typical of the dynamic, non-linear, earth system. Nonetheless, MMEDs can provide a warning mechanism into the consequences of human activities and alert the public to potential health threats and deteriorating environmental conditions. As such, MMEDs should receive increased scientific attention. However, the far reaching consequences of environmental disturbances within the context of complexity strongly argues for management initiatives that are precautionary—that is regulatory action before scientific proof of human-related deleterious effects and a shift in the burden-of-proof (concerning an activity's safety or sustainability) from the public onto the proponent.

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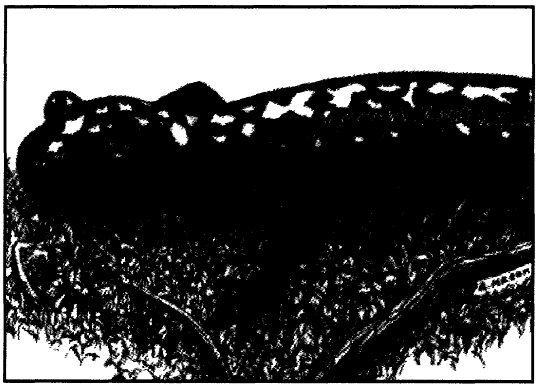
FOCUS ON NATURE ™ *by Rochelle Mason*



The SANTA CRUZ LONG-TOED SALAMANDER (*Ambystoma macrodactylum croceum*) grows to about five inches in length and is black with metallic gold spots on its back and white specks on its sides. It feeds on spiders, snails, centipedes, and earthworms. During the winter, this long-toed salamander breeds in two temporary, shallow ponds in Santa Cruz County in northern California. Eight to ten eggs are attached to vegetation bordering these ponds where the larvae mature for several months. Moist soil and small animal burrows in woodlands of oak and willow provide protection and needed moisture the rest of the year. Donating your time or money to a nature conservation organization will help protect and preserve the remaining habitat of this endangered species.

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Opinion

The Roadless Legacy

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Few creatures are more emblematic of the American wilderness than the huge, lumbering mountain of flesh and fur know as the grizzly bear. Not many Americans have seen one in the wild, however, and for good reason: the grizzly is officially listed as a threatened species in every state but Alaska. Thriving populations exist in only two areas of the lower 48: Glacier and Yellowstone National Parks.

The good news is that while much of America has changed in the last 150 years, the Bitterroot Mountains of central Idaho have not. Large expanses of unbroken forest still exist here. Grizzly bears, however, do not. While Lewis and Clark reported a large and healthy population of grizzly bears in the Bitterroot area in the mid 19th century, Idaho hunters and ranchers had nearly exterminated the bear in the region by the turn of the Century. The last known grizzly sighting in the Bitterroot took place in the 1940s.

The good news for the grizzly is that while hunters managed to kill all the bears, loggers could not fell all the trees. Now, thanks to the Roadless Area Conservation Initiative of the USDA Forest Service, loggers may never get a chance.

The Roadless Forest Conservation Plan is the largest land protection initiative of the last 80 years, as well as the most popular and participatory. A product of a two-and-a-half year regulatory process, the roadless forest protection plan was strengthened, at every stage of the debate, by citizen participation.

When the Forest Service held over 600 public meetings to explain the roadless forest plan, they found nearly every single community expressing overwhelming support for the initiative. Over a dozen state and national polls by eight different pollsters found support for roadless forest protection among Republicans as well as Democrats, Easterners as well as Westerners, and hunters as well as soccer moms. Over four hundred scientists and two thousand leaders of America's faith communities wrote the President, urging him to extend the strongest possible protection to roadless National Forest areas.

When the dust finally settled in December 2000, the Forest Service reported a record 1.6 million official public comments in support of roadless forest protection—seven times more public input than had ever been received for any other regulatory initiative in the history of the United States.

Exactly what were Americans supporting? A large number were supporting habitat protection, not just for grizzly bears, but also for bull trout, elk, mule deer, and a thousand other species on and off the endangered species list. Others Americans supported roadless forest protection because they saw these vast pristine areas as essential to their own recreational and spiritual renewal. For these Americans, the National Forest system is not a lumberyard or a construction site, but a place to commune with God's original design while having a little fun in the woods.

Economists weighed in with powerful economic reasons for supporting roadless forest protection, noting that National Forest land generated 30 times more revenue and jobs when used for recreational purposes than it did when used for timber sales.

Recreational organizations such as the American Canoe Association and the American Hiking Association weighed in with support for roadless area conservation, noting that the National Forests had over 800 million visitors a year (most of them voters). Almost none of them were interested in seeing pristine areas roaded, denuded, and reduced to stump and slash piles. "Protecting roadless areas is especially critical in the Southern Appalachians, where the demand for hiking, hunting, fishing, and other backcountry recreation is fast outgrowing the amount of protected public land," noted the Southern Environmental Law Center.

For the conservation community, roadless area conservation was key to protecting watersheds, wildlife habit and recreational opportunities in 39 states. Here too, however, each organization presented its own strengthening message.

Defenders of Wildlife, for example, argued that threatened species such as grizzlies and wolves required large tracts of wild western woodlands and that roadless forest protection was the only way to ensure their long-term survival.

For The Wilderness Society, the roadless forest protection initiative was a chance to designate as near-wilderness an area larger than the total amount of land added as wilderness since the Wilderness Act was passed in 1964.

For the National Audubon Society, which spearheaded the roadless forest campaign from its Washington, D.C., offices, the roadless forest protection initiative was a way of protecting vast expanses of habitat for birds and other wild creatures. Audubon noted that over 70 percent of Neotropical songbird species in the heavily roaded eastern and prairie states have been in decline for the last 30 years. Only in the intermountain west, where large tracts of unbroken forest still remain, were migratory Neotropical songbird populations still robust (Figure 1).

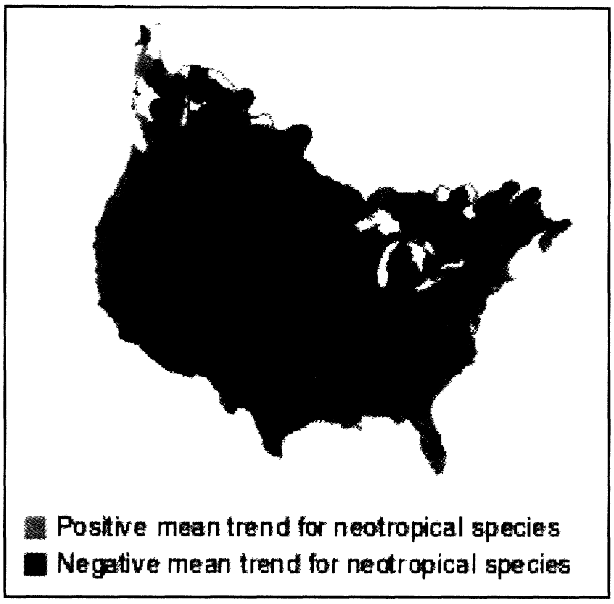

Figure 1. Trend of neotropical migrant birds. Map reprinted with permission from the Breeding Bird Survey: http://www.mbr-pwrc.usgs.gov/bbs/genintro.html.

On the other side of the coin, the arguments in support of increased road construction, logging and mining within roadless areas of the National Forest system were either weak or non-existent. Though roadless areas comprised nearly one third of the National Forest system, they accounted for less than *one quarter of one percent* of the national timber cut. With over 383,000 miles of logging roads winding through the National Forest system—eight times more roads than in the interstate highway system—it was hard to argue that more roads were needed for recreation or access.

The timber industry and a handful of allies on Capitol Hill argued that logging wild forest areas was one of the very best ways to prevent forest fires—a theory that drew open ridicule from scientists and editorial writers who noted that more than 85 percent of the lands most at risk for fire were in previously logged and roaded areas. How could forests unchanged for millennia be "out of balance" and in an "unnatural state"?

Arguments put forth by oil, gas, and mining interests sounded similarly bankrupt when trotted out into the court of public opinion. Most roadless areas had been open to oil and gas leasing for decades, but industry had expressed little interest in them since few deposits were large or worth the cost of recovery. With National Forest land accounting for less than one fifth of one percent of U.S. domestic oil and gas production, it was hard to argue that the fate of the nation rested on ripping new holes into a subset of this land—pristine forest areas that the industry had ignored for 50 or 100 years.

In the end, the fate of America's public forests was decided by the public, a situation ironic only because of its rarity. The final roadless forest protection rule protects 58.5 million acres of roadless forest in 39 states. The total area is larger than the entire National Park System.

One of the areas protected includes 7.8 million acres within the Bitterroot ecological system. This enormous expanse of roadless forest is now the largest tract of prime grizzly bear habitat in the continental United States—larger than the 4.2 million acres in the Northern Continental Divide ecosystem and the 5.2 million acres in the Yellowstone ecosystem. Though the Bitterroot is still grizzly-free, scientists and conservation officials expect that to change soon under a plan that would reintroduce wild grizzlies trapped in Montana to the region.

When that occurs, something truly monumental will have happened—the grizzly will have reclaimed land it had lost. Pushed up against the brink by a rising tide of "civilization", the grizzly will have gained ground, instead of lost ground, for the first time in 100 years. So too will have bull trout and salmon, elk and mule deer, and wolf and wolverine. As America's population has risen from 80 million in 1900 to over 280 million today, the wild lands these creatures need to survive has become increasingly rare.

What is true today will be no less true in 50 years, when the population of the United States is projected to rise past the 350 million mark. By then we will look back on the roadless forest conservation initiative from the advantage of time and distance and recognize it for what it truly is—a truly monumental achievement.

When the history of the environmental movement is written then, the foresight of President Bill Clinton and Forest Service Chief Mike Dombeck will be paired with that of President Theodore Roosevelt and his Forest Service Chief, Gifford Pinchot, a century before. Thanks in no small part to their vision, and a phenomenal outpouring of support from the American people, the grizzly has a very real chance of continuing as a *living* symbol of America's wilderness for generations to come.

News from Zoos

Great Ape Conservation Act

In a press release dated November 3, the American Zoo and Aquarium Association (AZA) praised the U.S. Congress and President Clinton for passing and signing into law HR 4320, the "Great Ape Conservation Act." "America's zoos and aquariums are passionately committed to conserving the world's wild creatures and their habitat. We are proud to be part of the powerful partnership that has achieved passage of this bill," said Syd Butler, executive director of AZA.

HR 4320 authorizes the appropriation of $5 million a year for the Department of the Interior to grant to organizations involved in the conservation of great apes—chimpanzees, bonobos, gibbons, orangutans and gorillas. These grants will provide financial resources for the conservation programs of countries within the range of great apes and projects of persons with demonstrated expertise in the conservation of great apes. Unfortunately, no funds have been appropriated for these grants for fiscal year 2001 as the Great Ape Conservation Act was signed into law after the passage of the FY 2001 Interior Department Appropriations bill. AZA is working diligently to secure some measure of funding for these important grants for the upcoming fiscal year.

AZA has supported HR 4320 from its inception on April 13, when it was introduced by Congressman George Miller (D-CA). Senator James Jeffords (R-VT) had introduced similar legislation in the Senate on 11 May 1999. AZA President Richard Lattis testified on behalf of AZA in support of HR 4320 during a June 20 hearing held by the House Committee on Resources. "For many years, the AZA Species Survival Plans (SSPs) have provided protection both in our care and in the wild, for endangered species from Partula snails to great apes," commented Lattis. "This bill was a logical next step in addressing the plight of the great apes."

Chief among the threats to great apes are habitat destruction, civil wars which drive humans into great ape habitat and the devastating increase in the illegal commercial hunting of forest animals for their meat, known as the "bushmeat" trade.

In 1999, 133 million people visited AZA's 188 accredited zoos and aquariums, and members daily educate visitors about the devastating effects of the loss of vital species habitat, as well as the illegal trade in endangered species parts and products. AZA facilities go far beyond the daily care and husbandry of animals—in 1999-2000, they supported nearly 1300 conservation and research projects in 80 countries.

"And while AZA zoos and aquariums have become the last stronghold for some species, we realize we cannot save them by zoo propagation alone," concluded Lattis in his testimony. "AZA and its member institutions will continue to work with Congress, Federal agencies, conservation organizations and the private sector world-wide to conserve these magnificent animals."

Banggai Cardinalfish Conservation Program

The Banggai cardinalfish project, which includes an exhibit featured in the Indo-Pacific segment of Conservation, Outreach and Observation Lab (COOL) at the New Jersey State Aquarium, is the culmination of three years of successful research and captive breeding under the direction of the aquarium's Manager of Science and Conservation, Alejandro Vagelli.

The New Jersey State Aquarium is the only facility in the world where this species' life history has been studied. It is the research lab's goal to develop techniques for the reproduction and rearing of aquatic species; in particular, marine tropical fishes, and to use this as a tool to further understand and describe their basic biology.

The Banggai cardinalfish inhabits a small triangular area of Banggai and other nearby islands in Indonesia. Due to this species' vulnerability to exploitation for the pet trade, coupled with low levels of productivity, the continued survival of the cardinalfish is in question just five years after its rediscovery by science.

The program will provide the first scientific evaluation of the Banggai cardinalfish population status and will yield essential data on its reproductive ecology in the wild. In addition, the aquarium will establish a breeding program with the Indonesian Institute of Sciences and local collectors in an effort to develop a specific methodology for the captive breeding and care of the Banggai cardinalfish.

The American Zoo and Aquarium Association's Conservation Endowment Fund provided funding for the Banggai project.

Information for News from Zoos *is provided by Joseph Lankard of the American Zoo and Aquarium Association.*

Marine conservation biology funding website

The Marine Conservation Biology Institute recently added a new feature to its website—a comprehensive directory containing federal funding opportunities for marine conservation biology research. This is the first attempt at a directory of its kind. The directory is intended to be a compendium of current research funding opportunities for all scientists seeking support. You can visit the site by clicking on "Sources of federal funding" at http://www.mcbi.org.

Integrated ecological symposium

The Second Annual Integration Across Ecological Scales symposium, entitled "Complexity, Biodiversity, and Ecosystem Function," will be held at Texas A&M University on 24 March 2001. The event will be a one-day symposium with seminars from distinguished ecologists, such as Lenore Fahrig, J.P. Grime, Dan Janzen, Jim Kitchell, Ariel Lugo, Judy Meyer, Bruce Milne, and Dan Simberloff. The aim of the symposium is to encourage integration across diverse fields of ecology and to provide insight into the complex relationship between biodiversity and ecosystem function across multiple scales. Admission is free and all are welcome to attend. If you are interested in attending please visit our web site (http://wfscnet.tamu.edu/int/integration.htm) and register online.

Marine mammal conference

The 14th Biennial Conference on the Biology of Marine Mammals will be held from 28 November to 3 December 2001 in Vancouver, British Columbia. The Conference is sponsored by the Society for Marine Mammalogy and the Vancouver Aquarium Marine Science Centre is hosting this international event. Current research on whales, dolphins, seals, sea lions, and other marine mammals will be showcased through spoken and poster presentations. Special events, video evenings, and vendor exhibits are planned as well. The conference Web site (http://www.smmconference.org) is designed to be the primary resource for all information pertaining to the meeting, and will be updated frequently, so check back often. General inquiries: e-mail mmconf@vanaqua.org. Scientific program inquiries: e-mail sciprogram@vanaqua.org.

Announcements for the Bulletin Board are welcomed. Some items have been provided by the Smithsonian Institution's Biological Conservation Newsletter or found on the Society for Conservation Biology Bulletin Board (http://conbio.net/scb/Services/Bboard/).

Endangered Species UPDATE

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