Endangered Species UPDATE

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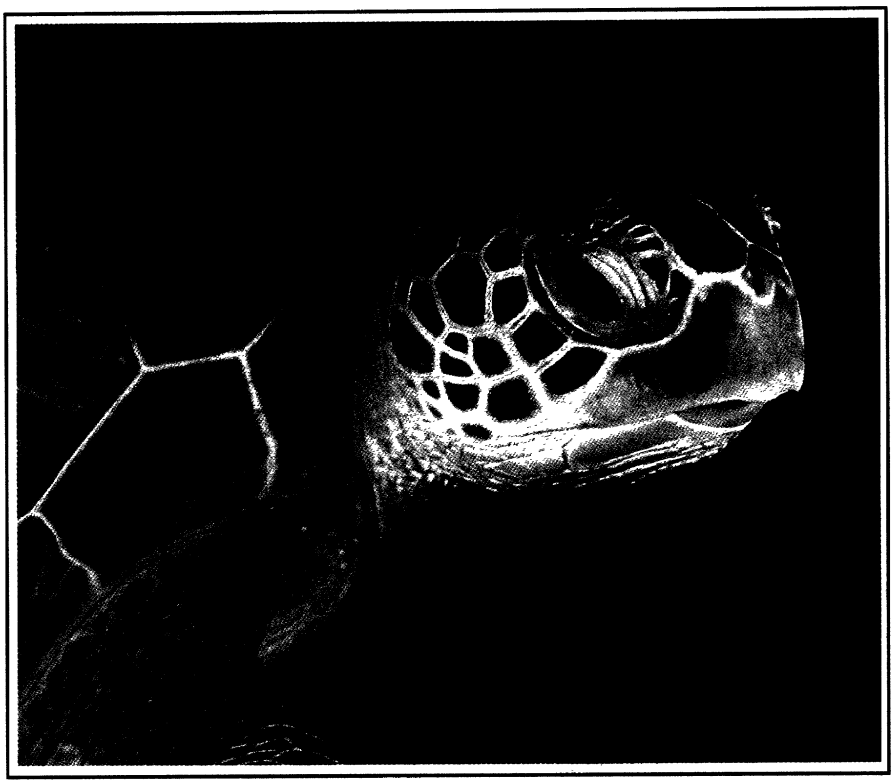


Letter from the Editor

With 2002 upon us, I'd like to give you a brief update on the *UPDATE*.

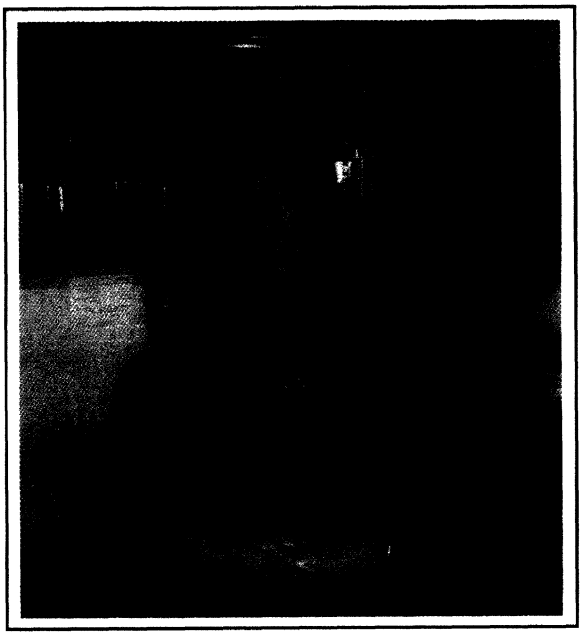
First, we are in the process of instituting an on-line subscription. For a reduced fee ($20), you can receive a user name and password that will give you access, through our web page, of PDF versions of the year's issues.

Second, to keep up with growing production costs, we have increased subscription rates. The new rates are: $33 (regular subscription), $25 (senior or student), $20 (on-line subscription), and $78 (institution/business). As always, please add $5 for each address outside the United States, and we gladly accept any and all tax-deductible contributions.

Third, after almost 5 years as the *UPDATE*'s Managing Editor, I am stepping down. The *UPDATE* is entirely student run, and upon my graduation, Beth Hahn, a Master's student at the University of Michigan's School of Natural Resources and Environment (SNRE), will be the new Managing Editor. Our Publication Editor, Jennifer Jacobus MacKay, a doctoral student at SNRE, will continue with the *UPDATE* through Spring of 2002. Working with all of you over the past several years has been a real pleasure — I will miss the *UPDATE*, but look forward to seeing it grow under Beth and Jennifer's leadership.

I hope you have a safe and happy 2002.

Sincerely,
M. Elsbeth McPhee



Endangered Species UPDATE

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Cover: Green turtle (*Chelonia mydas*) at South Point on Pulau Sipidan, Borneo, Malaysia. Photo used with permission.

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Single-species versus Multiple-species Recovery Plans: A Review of the Stock Island Tree Snail Recovery Plans

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Abstract
Under the ESA all federally listed species are required to have a recovery plan. While early recovery plans often focus on single species, during the past decade there has been an emphasis on developing multi-species recovery plans. This article examines the strengths and weaknesses of each type of plan using the Stock Island tree snail as an example. Recent plans, regardless of type, tend to be more comprehensive and scientifically based than earlier plans, and multi-species plans in particular reflect a better understanding of species and their relationship to the ecosystem. They also make more of an attempt to include the public in the recovery process. However, some multi-species recovery plans are quite large and their size alone could hinder their implementation. Some species with unique needs may benefit more from a single-species recovery plan. The type of plan is irrelevant, however, if adequate funds are not made available for implementation.

Introduction
Section 4(f)1 of the Endangered Species Act requires that recovery plans be developed and implemented for the "conservation and survival" of all listed species. To date, a large number of these species are still without recovery plans, and many of the plans that are in place lack sufficient information to effectively guide recovery. On the positive side, there has been an evolution of sorts in both the approach (single- versus multi-species plans) and content in creating new and revising existing recovery plans, with recent recovery plans having a much greater emphasis on habitat. This paper provides an overview of two such plans, using the Stock Island tree snail as an example.

Stock Island tree snail
Natural history
The Stock Island tree snail, *Orthalicus reses reses (Say)*, is a large (45 to 55 mm in length), conical snail, white to buff in color, with three spiral bands and numerous purple-brown axial stripes (Deisler 1982). It is a subspecies of the genus *Orthalicus*, a group of large arboreal snails occurring primarily in Central and South America and in very limited areas of South Florida.

There are two other species of *Orthalicus*: *O. floridensis* and *O. reses nesodryas*. *O. floridensis* is the most widespread and, historically, has occurred throughout the Florida Keys. *O. reses nesodryas* has occurred throughout the Keys as well, but is found mainly in the mid to lower Keys. Due to anatomical differences, the two subspecies of *O. reses* are not believed to interbreed (USFWS 1982, 1999).

The Stock Island tree snail inhabits hardwood hammocks and is found more often on smooth-barked trees, probably because smooth bark allows greater ease of mobility (Voss 1976). Preferences for hammock edge or interior have been observed (Tuskes 1981), although no scientific data is available to support this observation.

This particular snail is active primarily during the wet season (May through November) with aestivation occurring during dry periods. It is hermaphroditic and may locate others of its kind through mucus trails. Mating occurs in late summer or early fall, with egg deposition lasting anywhere from 15 to 105 hours (Deisler 1987; McNesse 1989). The eggs are deposited into cavities located in the soil humus at the base of trees, where they remain until the onset of the next rainy season. Once hatched, the snails can live up to six years, although 2.11 years is the mean.

Little is known about the snails' feeding habits or food preferences. It is believed they feed on the epiphytic growth (e.g., fungi, algae, lichens, etc.) occurring on tree trunks, branches, and leaves. They feed throughout the day and night, with peak activity occurring from late afternoon to mid-morning, as well as after rains.

Status and trends
The Stock Island tree snail was first listed as threatened on July 3, 1978. Although no historical population numbers were available at that time, the snail had been extirpated from nearly all of its historical range, i.e. Stock Island and Key West.

At the time that the first recovery plan was prepared in 1982, there were no Stock Island tree snails ob-

served in Key West, but there were an estimated 200 to 800 individuals located on the Stock Island Golf Course. Then, in 1997, a population of c. 65 individuals was discovered in a Key West residential subdivision. However, by the time the recovery plan was revised and incorporated into the 1999 South Florida Multi-Species Recovery Plan (MSRP), the population at the golf course had been entirely extirpated, and the status of the residential population in Key West was unknown.

Aside from its historical range, the Stock Island tree snail was known to exist at several introduced sites, such as Calusa Cove Campground and John Pennekamp Coral Reef State Park in Key Largo, as well as Monkey Jungle in Miami. However, surveys conducted in 1995 and 1996 found these populations either non-existent or present but in extremely low numbers. The primary cause of decline for all populations has been habitat loss and/or modification, but hurricanes, drought, overcollecting, and predation have had negative effects as well (USFWS 1982).

Stock Island tree snail recovery plan

Overview

The first Stock Island tree snail recovery plan was prepared in 1982 and approved in March of 1983. Although limited in content, its format was consistent with other single-species recovery plans written in the late '70s and early '80s in that it had an introduction/natural history, a section on recovery, and an implementation schedule.

To summarize, the recovery objective of the *Stock Island Tree Snail Recovery Plan* is stated as follows: The Stock Island tree snail shall be considered "recovered" and no longer in any danger of extinction when the following conditions are achieved (USFWS 1982):

(1) They are present in a normal density throughout 20 acres on Stock Island Golf Course;

(2) There is no consistent downward trend for more than two years throughout a regular monitoring program beginning 10 years before such a determination should be made;

(3) There are agreements in place between the state government and the owners of the golf course to ensure that the remaining snail habitat will not be allowed to decrease in extent and/or quality; and

(4) A minimum of 30 populations reestablished (and monitored) in suitable areas on Key West.

To accomplish the above objectives, the recovery portion of the plan calls for the following two tasks (which are further divided into subtasks):

(1) Protect and monitor the population at Stock Island Golf Course through interactions with owners, public relations, and minimization of predation; and

(2) Establish and monitor adequate reserve populations throughout its historical range by locating potential sites and determining proper stocking procedures.

Finally, a brief narrative of the subtasks and an implementation schedule (although scant) is given.

Strengths and weaknesses

This single-species plan had some strengths, in that it established biological guidelines for long-term recovery, attempted to reestablish populations in the snail's historical range, and priorities were identified in the implementation schedule. However, the weaknesses of the plan far outweighed the strengths. Because there was so little information available, no scientific basis was given for determining an adequate population size. Predation was discussed, but competition was not. The potential impacts of environmental variability were mentioned but did not appear to be calculated in the recovery numbers. The plan did not allow for movement between populations. There were no maps, no emphasis on multi-species, no specifics as to how tasks would be accomplished, no political, social, and economic components that might affect recovery, no budget, and finally, no start dates on the implementation schedule.

Multi-species recovery plan for south Florida (MSRP)

Overview

The new *Multi-Species Recovery Plan for South Florida* (MSRP), approved on May 18, 1999, is one of the largest recovery plans to date, addressing 68 federally listed species (including the Stock Island tree snail) and 23 natural communities. The geographic scope exceeds 65,000 square kilometers, including the Kissimmee River-Lake Okeechobee-Everglades, the Caloosahatchee River, and the Peace River-Myakka River watersheds.

A group of more than 200 experts, known as the Recovery Team, worked together to prepare the MSRP, which now replaces all existing recovery plans for the applicable species. The new plan also contributes to range-wide recovery plans for species present in South Florida but assigned to FWS offices outside of South Florida (e.g., the Florida panther (*Puma concolor*)). The MSRP is also an important component of the greater South Florida Ecosystem Restoration effort (a multi-billion dollar restoration effort presently underway).[1]

Components of the MSRP

The MSRP has seven sections: (1) Executive Summary, (2) Introduction, (3) The South Florida Ecosystem, (4) The Ecological Communities, (5) The Species, (6) Implementation, and (7) Appendices. The two primary components of the plan, however, are The Ecological Communities and The Species.

The Ecological Communities

The Ecological Communities section provides a community/ecosystem perspective for maintaining biodiversity. It contains accounts for all 23 natural communities that occur in South Florida in which the 68 federally listed species inhabit. Each account discusses biological composition, status, trends, management, and restoration needs,[2] and recommendations to manage, reconstruct, or restore the community.

The Species

The Species section is a compilation of accounts for all 68 federally listed species. Each account has two parts. Part I summarizes the biology, ecology, status, trends, and management issues. Part II discusses recovery objectives and criteria,[3] species-level actions, and habitat-level actions. Again, these accounts serve as a revision to all existing recovery plans for which the Fish and Wildlife Service's South Florida office has the recovery lead. Since the natural history, status, and trends for the Stock Island tree snail were presented earlier, I will only discuss the recovery portion of the species account.

Recovery for the Stock Island tree snail

The sole recovery objective, according to the multi-species plan, is to delist the species. Delisting can occur only when "further loss, fragmentation, or degradation of suitable occupied habitat in the Lower Keys has been prevented; occupied habitat on priority acquisition lists for the Lower Keys is protected either through land acquisition or cooperative agreements; potential habitat on these protected lands is managed, restored, or rehabilitated to provide habitat for the Stock Island tree snail; four stable populations of the Stock Island tree snail are established throughout the Lower Keys" (USFWS 1999). A summary of both the species-level and the habitat-level recovery actions needed to accomplish these criteria is given below.

Species-level recovery actions

(1) Determine the distribution and status of the Stock Island tree snail in the Keys and southern mainland of Florida;

(2) Protect and enhance the existing populations through ESA Section 7 consultations, reintroductions from wild populations, reduced disturbance and mortality, etc.;

(3) Determine if the total population size is large enough to prevent functional extinction and genetic extinction;

(4) Monitor Stock Island tree snail populations;

(5) Increase public awareness and stewardship; and

(6) Establish measurable reclassification and delisting criteria.

Habitat-level recovery actions

(1) Prevent degradation of existing habitat through acquisition of protection and management;

(2) Restore suitable habitat;

(3) Conduct research to determine habitat needs;

(4) Monitor the status of snail habitat; and

(5) Increase public awareness of habitat and instill stewardship.

Implementation

Clearly, what is available on the web site (see http://verobeach.fws.gov/vbms4.html) under Implementation is simply an overview rather than the actual implementation plan. This section describes how an implementation plan will be developed in accordance with the Interagency Cooperative Policy on Recovery Plan Participation and Implementation. Part of this process involves establishment of a Multi-Species/Ecosystem Recovery Implementation Team (MERIT) whose objectives are to:

(1) Prioritize recovery actions from an ecosystem perspective;

(2) Recommend restoration activities at the species and community levels;

(3) Publish technical/agency draft implementation schedules (notices for such to be posted in the *Federal Register*); and

(4) Coordinate activities with the various subgroups of the greater South Florida Ecosystem Restoration (SFRESTORE) effort.

While the plan states that MERIT will have the responsibility for updating recovery costs, no specifics for implementation are given at this time other than to say that the MSRP is integrally tied to SFRESTORE. However, the Comprehensive Everglades Restoration Project (CERP)[4] portion of SFRESTORE has approximately an $8 billion price tag, and 17 of the 68 federally listed species in the MSRP are directly dependent upon the success of it. As of May 31, 2001, MERIT had met three times.

Strengths and weaknesses

For the Stock Island tree snail, the MSRP has many more strengths than the initial single-species plan. The MSRP emphasizes rebuilding populations within the historic range while continuing to protect existing populations, something that is often overlooked in older recovery plans. It discusses not only predation and competition but environmental variability as well. The MSRP uses scientific and technical methods for determining stable populations and defining the criteria for endangered, threatened, and delisting. It also takes a community approach and uses the adaptive management framework. Finally, the MSRP addresses both the political and social aspects of recovery.

At this point, the biggest weakness appears to be the ambitiousness of the plan itself. In addition, it is difficult to determine the responsibilities assigned to each agency or institution since an

implementation plan and schedule have not yet been completed and made available for review. Also, it is not clear which criteria MERIT will use to prioritize different species.

Conclusion

Advances in our understanding of certain species as well as their relationship to the larger ecosystem have clearly had a positive impact on recent recovery plans. While some species with unique needs may benefit more from a single-species recovery plan, multi-species recovery plans, if well coordinated, have the potential to preserve several species simultaneously, perhaps at a lower cost. Multi-species plans can be small, focusing on just a few plant or animal species, or quite large, such as the MSRP. The success of larger plans will not be measurable for years. Each type of plan has strengths and weaknesses, and those discussed for the Stock Island tree snail are not unique. Whether a recovery plan is single- or multi-species based is often irrelevant given the lack of funding available for its implementation. Funding, of course, is highly dependent on the political climate at the time. Therefore, it is important to have the best possible plan on record should the funds become available.

Footnotes

1 The major goals of South Florida Restoration are to (1) "get the water right," i.e. restore natural flow, (2) restore and enhance the natural system, i.e. healthy populations and habitats, and (3) transform the built environment, i.e. no more degradation. The MSRP applies to Goal #2.

2 Restoration is used as an analogous term to recovery at the community level and is defined as any activity which improves the overall ecological condition of a natural community or disturbed site (USFWS 1999).

3 The first page of each species account contains a status box that gives the official listing, a critical habitat designation (if applicable), and whether or not it is a new or revised plan or contributes to a range-wide plan.

4 Formerly known as the RESTUDY, CERP is the implementation phase of the RESTUDY, which is a series of environmental improvements over a period of 25 years, with an estimated cost of $7.8 billion.

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Legislative UPDATE

Whaling Update

Last summer the House Committee on International Relations discussed whaling issues and policies for the future. Though not conclusive as of yet, the two bills up for vote are House bill, H.CON.RES.180, and Senate bill, S.RES.121, which address whaling among native American peoples, commercial whaling, and international trade of whale meat.

H.CON.RES.180 is in favor of allowing native peoples to continue harvesting whales in the U.S. The bill asserts that designating a South Pacific Sanctuary for whales should be avoided until the International Whaling Commission's (IWC) Scientific Committee produces scientific regulations and criteria, monitoring methods, and research programs for such a sanctuary. The bill directs U.S. delegation members to urge these policies upon the IWC.

In contrast, S.RES.121 supports an increase in whale sanctuaries. It also restates the United States' opposition to commercial and scientific lethal whaling, advocating that the President use all possible diplomatic measures to communicate the U.S. opposition to this whaling and that the U.S. challenge any efforts made at the 53rd IWC meeting to resume these methods of whaling. Finally the bill asks that at the 12th Conference of the Parties to the Convention on International Trade in Endangered Species, the U.S. resist any attempts to downlist any threatened or endangered whale population or reopen international commerce in whale meat.

Endangered Species Act Update

There are several bills to update the Endangered Species Act of 1973 on the House and Senate floors. Two of these are as follows:

Endangered Species Recovery Act of 2001 (S.911)

o Instructs the Secretary of the Interior to use observed, field-tested, and/or peer-reviewed data in determining the addition of species to the endangered or threatened lists.

o Dictates that specific minimum documentation is required to change the status of a species, that upon request at least one public hearing be held in each State affected by this change, and that public information be provided regarding the reason for this change.

o Provides guidelines and schedules by which the Secretary is to abide in creating and executing endangered/threatened species recovery plans.

o Commands Federal agencies to keep inventory of endangered and threatened species on agency lands and waters and to comply with certain requirements prior to engaging in any activity that could effect these species.

o Permits the Secretary to make contracts with non-Federal parties to adjust habitats to benefit endangered or threatened species.

Endangered Species Criminal and Civil Penalties Liability Reform Act (H.R.1404)

o Declares a person exempt of liability for any environmental criminal or civil infraction, assuming the action otherwise lawful and that it is not ended within 30 days of notice.

o Affirms that it is a legitimate defense, in a case where a defendant did not respect an endangered or threatened species, that the defendant did not know, nor could reasonably have known, that the indicated species was endangered or threatened.

o Permits the Secretary to enter into arrangements with and grant up to $10,000 to non-Federal persons for the creation, restoration, or enhancement of that benefit endangered or threatened species.

In Support of Hunting

The House Subcommittee on Fisheries Conservation, Wildlife, and Oceans is considering a bill (H.CON.RES.44) that acknowledges hunting as a valid and necessary means of wildlife resource management. It attests that lawful hunting aids in maintaining healthy wildlife populations. The bill further states that no Federal laws should be passed, aside from those protecting endangered, threatened or non-game species, to regulate the hunting or consumption of wildlife. It does, however, state that hunting is to be performed in a sportsmanlike manner.

Bear Protection Act of 2001

The Bear Protection Act of 2001 (S.1125) aims to restore the diminishing North American bear population. It bans the import or export of, the possession of, or any interstate commerce of bear entrails in the U.S. It further directs the Secretary of the Interior to promote international efforts to protect the bears. However, S.1125 does not affect individual State regulations regarding bear populations and lawful hunting thereof.

Source: Library of Congress, *Thomas*. http://thomas.loc.gov/

Information for Legislative UPDATE *is provided by the UPDATE's staff research coordinator, Ashley McMurray, an undergraduate student of public policy and the environment at the University of Michigan.*

An Optimization Model to Select Redwood Stands for the Conservation of the Marbled Murrelet in the Headwaters Forest HCP

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Abstract

*This work describes an explicit method by which alternative stand selection scenarios concerning the threatened marbled murrelet (*Brachyramphus marmoratus*) in the Headwaters Forest Habitat Conservation Plan were generated and evaluated. Preservation goals and timber harvesting goals are simultaneously considered. An integer programming model (classical 1,0 knapsack problem) is applied to identify sets of redwood groves that optimized marbled murrelet nesting habitat value for given values of foregone timber production. Alternatively, the results can be interpreted as minimizing applicant cost for given levels of murrelet habitat value. The outcome of the analysis does not show that a small number of very high quality selections would reserve most of the available murrelet habitat. Instead, the analysis supports the contention that the more old-growth that can be reserved, the better the measures of nesting habitat become. Ultimately, the results of this analysis were not used for negotiating the final Headwaters Forest Habitat Conservation Plan. However, the grove selection optimization model is valuable in that it provides a general method for balancing habitat value and economic value.*

Introduction

The Headwaters Forest in northern coastal California is infamous for one of the premiere conservation battles of the 1990s. The contention is over the preservation of old-growth forest, especially redwood habitat. Listed species that are affected include the northern spotted owl (*Strix occidentalis caurina*), coho salmon (*Oncorhynchus kisutch*), and marbled murrelet (*Brachyramphus marmoratus*). This paper focuses on a decision aid that was applied during the negotiations over the amount of private timberland that would be set aside as nesting habitat for the marbled murrelet.

The best-known conservation activities in the Headwaters were associated with the government purchase of a 7,500-acre tract of old-growth redwoods. Lesser known was the development of a Habitat Conservation Plan (HCP) that is a 50-year agreement between the U.S. Government and Pacific Lumber Company (PL) governing activities on approximately 200,000 acres that are owned privately by PL. The decision model described herein was applied in the context of the HCP.

The marbled murrelet is a seabird that forages in marine coastal areas and is dependent for nesting on the large branches found on old-growth trees such as redwood and Douglas-fir (Naslund 1993; McCarthy 1993). In California, redwood-dominated stands relatively near the coast are considered to be of prime importance (Hunter et al. 1998). The severe loss of old-growth forest habitat has reduced populations in California, Oregon, and Washington to such an extent that the marbled murrelet (for those states) was listed as federally threatened in 1992 (USFWS 1992). A difficult conflict inevitably arises from the marbled murrelet's dependence on old-growth redwood trees for successful nesting and reproduction. Because of the high economic value of such forests for timber harvest, habitat reserves are potentially very costly for a company such as PL. The result is a direct conflict between species protection and economic hardship imposed on a private rights holder. The HCP has to balance both interests. This study uses data developed during the HCP negotiations in the late 1990s to identify "optimal" alternatives that achieve the greatest habitat protection for a given amount of timber volume set aside for conservation. Not just a single solution is created. By varying the limit on foregone harvest, a set of points representing an optimal tradeoff curve between marbled murrelet habitat value and applicant cost can be generated.

Data

Of the 200,000 acres of PL property covered by the HCP, fewer than 10,000 acres remained that were considered to be prime habitat for

murrelet nesting. At the time (late 1997), these potential reserved groves were delineated as 23 different stands (Table 1). (It must be noted that these stand boundaries were later changed during the course of the negotiations, and thus no correspondence can be drawn between Table 1 and the final HCP negotiated in March 1999). Many stands were composed of a mix of forest types, including second-growth, partially cut old-growth, and pristine old-growth. Thus, murrelet habitat value may be quite variable within stands. The best measure of murrelet reproductive habitat quality available at the time was volume of old-growth timber (both partially cut and pristine) in a stand. An alternative measure was the ratio of a stand's "core" old-growth area to the "edge" old-growth area (again, including all types of old-growth).

Edge is defined as the outer 50-meter strip of old-growth area along the stand periphery surrounding the core. A greater core/edge ratio translates to better habitat value since edge effects are considered to diminish successful reproductive output (due to nest predation by crows, etc.). The "cost" to the company of preserving any stand is the volume of harvestable timber within the stand. While habitat value is measured in terms of the old-growth trees necessary for marbled murrelet nesting, cost to the HCP applicant (PL) is measured in terms of any type of merchantable timber existing within a stand.

Since this model uses sensitive corporate data belonging to PL, it is necessary for purposes of this manuscript to conceal the true volume of timber (old-growth and otherwise) in the respective stands. Accordingly, I have modified timber volume per stand by creating a relative index, which I term board foot index (BFI). BFI is created simply by multiplying board feet by a constant. In this way the relative value of each stand is maintained while maintaining company confidentiality. Only relative, not absolute, habitat and economic values are required by the optimization model.

Acres	Total BFI	Old-Growth BFI	C/E Ratio
160	8.9	4.81	1.27
121	3.45	2.11	0.81
371	63.12	45.32	2.18
128	15.46	1.33	0.26
84	2.52	2.26	1.11
514	25.41	20.37	1.95
190	18.23	13.43	2.85
336	54.22	35.87	2.46
398	23.77	19.12	2.96
851	88.3	64.69	2.65
346	17.24	12.19	3.53
867	84.08	59.25	1.30
271	11.87	9.82	1.88
80	2.98	1.97	1.23
187	16.01	10.46	4.53
34	1.18	1.00	0.12
386	24.56	15.16	3.04
240	17.65	12.94	1.98
385	13.52	9.5	1.95
259	19.92	17.74	2.78
260	23.06	16.24	1.67
8	1.32	1.12	0.18
unavailable	54.91	34.9	0.49

Table 1. Grove Data as of Late 1997. Stands of timber in the planning area containing nesting habitat for the marbled murrelet, by acres, BFI, and core-area/edge-area ratio. Stand boundaries are those used by negotiators as of late 1997 and have since changed.

Defining the model

As a verbal definition, determining which redwood stands on PL property should be set aside for marbled murrelet nest habitat can be stated as:

(1) Maximize reproductive output of the local sub-population,

(2) Minimize cost to the applicant.

This definition of the redwood stand selection problem in the area of the Headwaters Forest can be translated to a mathematical form. This mathematical form is an integer programming model that can be solved to yield a number of alternatives. Each alternative represents a different combination of stands (groves) that would be protected. A stand combination corresponds to a total amount of foregone harvest in terms of total BFI, and a total amount of nesting habitat value for the marbled murrelet. The latter is expressed as total volume of old-growth in BFI, or as the total ratio of core area

to edge area among the selected stands, depending on which measure of habitat value is being used in the model.

Model notation

The set of 23 stands eligible for selection as reserves in the HCP is indexed with i.

P_i = marbled murrelet nesting habitat measure for stand i. (Here, P_i is either the volume of old-growth redwood, measured in BFI, or the ratio of core area to edge area.)

F_i = BFI of extractable timber in stand i.

T = maximum level of extractable BFI allowed to be set aside in the set of selected stands (*an adjustable parameter*, the measure of cost to PL of foregone harvest).

X_i = 1 if stand i is selected for protection in the HCP; 0 if not.

Model formulation

The following model is designed to select that set of stands that attains the maximum total stand habitat value for the marbled murrelet given a limit on the maximum amount of timber that the applicant must set aside. By varying this limit (T), a set of points representing the optimal tradeoff between marbled murrelet habitat value and timber lost to PL can be generated. A high value of T corresponds to a relatively large loss of harvestable timber to the applicant (high amount of timber is allowed to be set aside in selected reserves). A low value of T represents allowing relatively little timber to be set aside in reserves, meaning a smaller financial loss to the applicant (but also relatively little reproductive habitat set aside for the murrelet). This integer programming model is an application of a classic mathematical form known as the 1,0 knapsack problem (Wagner 1975). The model is formulated in Box 1.

Box 1: Model Formulations

(1) Maximize total marbled murrelet nesting habitat value across the set of selected stands.

$$Maximize \ \sum_i P_i X_i \ subject\ to:$$

(2) Total BFI of harvestable timber set aside in the selected stands cannot exceed T.

$$\sum_i F_i X_i \leq T$$

(3) Integer restrictions for each i.

$$X_i \in \{0,1\} \text{ for each } i$$

The objective function (1) sums to the total habitat measure associated with a set of selected redwood stands or groves. The 1,0 variable X_i will be valued at 1 if grove i is selected and 0 otherwise. Thus, in (1), the value P_i is incurred for each selected stand. At optimality, a set of stands will have been selected and had their respective X_i variables set to 1 such that the objective will sum to the maximum total murrelet nesting habitat measure possible given the problem constraints. While any redwood stand that is selected contributes an amount (P_i) to species habitat value, it also contributes an amount (F_i) to applicant cost in the form of lost timber. Constraint (2) limits total applicant cost by limiting the total BFI among the selected reserved stands to a maximum value of T. T is a parameter that can be set at any desired value. By solving the knapsack problem for various values of T, many different alternative combinations of total habitat value protected and total timber set aside can be generated. Constraint (3) restricts the decision variables to being binary integers. Thus, any solution must contain whole stands, not portions of stands.

Note that P_i can represent different measures of murrelet habitat value. For our application here, we use two different measures: quantity of old-growth redwood (in BFI) present in a stand and the core-area/edge-area ratio of the stand. Having two different measures of the value of each stand means that we will solve two sets of knapsack problems, one for each habitat quality measure. Each set of problems is created by using a range of different values for T, which represents the maximum applicant cost for a solution. In each set of problems, the measure used for merchantable BFI in a stand (F_i) is unchanged. Note that the volume-based P_i differs from F_i due to the mix of timber types within a stand. For example, a stand that contains 60 BFI of harvestable redwood timber may only contain 40 BFI of old-growth redwood, both uncut and residual, the remainder consisting of second-growth timber.

Model results

All solutions were obtained by applying commercial off-the-shelf math programming software (CPLEX), and all solution attempts easily reached optimality. The relatively small size of the Headwaters problem made this approach very viable. Figure 1 graphs thirty runs of the 1,0 knapsack problem where P_i is defined as the BFI of old-growth redwood in stand i, and the parameter T ranges from 20 BFI to 600 BFI in increments of twenty BFI. Old-growth volume is one of the most basic measures that can be used to estimate marbled murrelet nesting habitat value. Each point in Figure 1 corresponds to a set of stands selected by the model. The horizontal axis represents, from left to right, increasing values of T, the amount of timber in reserved stands. For a given constraint on the volume of BFI on the horizontal axis, the 1,0 knapsack model identifies the set of stands that yields the maximum amount (in BFI) of old-growth redwood. For example, one solution identified in Figure 1 is generated by

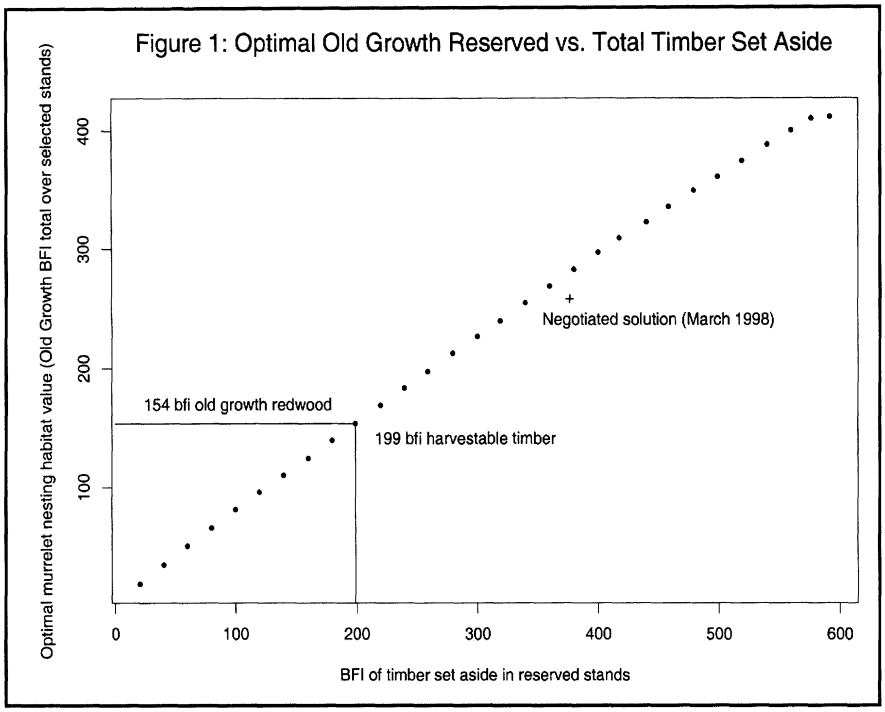

Figure 1: Optimal Old Growth Reserved vs. Total Timber Set Aside.

setting T to 200 BFI. The optimal solution consumes 199 BFI of harvestable timber and reserves 154 BFI of old-growth redwood. This solution consists of eleven selected stands. The reason that it takes 199 BFI on the horizontal axis to protect 154 BFI on the vertical axis is that the values on the horizontal axis include all harvestable timber, not just old-growth. Not surprisingly, Figure 1 indicates that there is a direct correlation between the quantity of timber that is reserved and the quantity of old-growth forest that can be provided to the murrelet.

Figure 2 graphs another thirty runs. This time the value of a stand is the core-area/edge-area (C/E) ratio. Again, the relationship between BFI of timber that is set aside and total murrelet habitat value (as measured by the sum of the core/edge ratios of the selected stands) is linear, at least over the range from low to intermediate BFI values. Where the slope of the curve flattens (about 200 BFI and total C/E = 33), further cost to PL starts to yield decreasing returns for the total core/edge objective.

Discussion and conclusion

Some general comments on the tradeoff curves in Figures 1 and 2 are warranted. The integer programming model is formulated and solved in terms of optimizing total nesting habitat value for a given constraint on applicant cost. The graphical interpretation of this is that for a set position on the horizontal axis, the model finds the highest point in the vertical direction that is a feasible solution. However, the knapsack model and graphical results can also be used indirectly to find, for a given level of habitat protection, what is the minimum applicant cost. For example, if negotiators could agree that a total C/E value of 33 would be sufficient habitat value conserved under the HCP, the knapsack model identifies the minimal amount of foregone timber harvest as about 200 BFI (Figure 2), and that particular set of stands would be revealed. It is important to realize that the knapsack model results and the graph can be interpreted in both of these ways, either from PL's viewpoint or from the biological viewpoint.

It is also important to realize the difference between optimal and suboptimal solutions in the figures. Points above the curve are infeasible — no additional habitat protection can be attained for the amount of applicant cost. Points below the curve (which are numerous) are feasible but are suboptimal. Such points (not

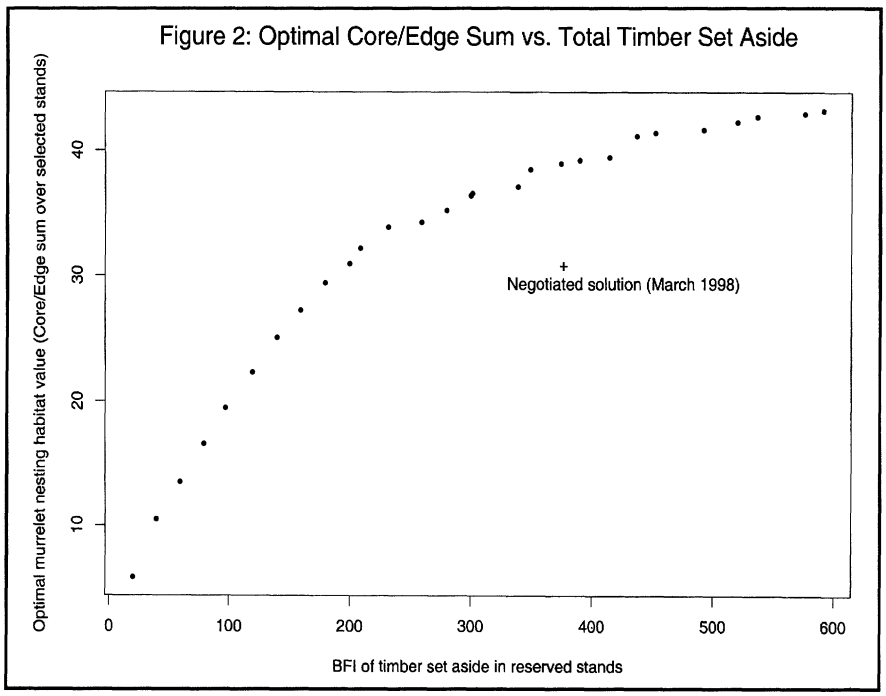

Figure 2: Optimal Core/Edge Sum vs. Total Timber Set Aside.

graphed) represent solutions that would require a higher applicant cost to reach a given level of murrelet protection; or, alternatively, that would reach a lower level of murrelet protection for a given applicant cost. The main value of the optimization exercise herein is that it identifies those solutions that represent "non-inferior" points (graphed in the figures). From the perspective of any non-inferior point, no gain can be made in either objective without sacrificing some of the other objective. Without the use of the integer programming model, it is easily possible that decisions would be considered using suboptimal alternatives existing below the optimal tradeoff curve.

The shape of the non-inferior tradeoff curves, particularly in Figure 1, shows a strong linear relationship between timber reserved and habitat reserved. If instead the tradeoff curve had a convex shape and was relatively steep for low values of BFI set aside and progressively flatter as foregone timber increased, that would show that there were some clearly superior sites that could attain relatively good murrelet protection, and that complementing those with additional sites would add relatively little to murrelet protection. From a negotiating viewpoint, this would likely be a desirable result, opening the door to a "win-win" type of solution for both sides. However, Figure 1 shows a nearly straight line, indicating that most of the groves as defined are good stands in terms of what they can add to marbled murrelet protection. Simply put, the more salable timber set aside, the more habitat available to the bird. It is not surprising to see this linear pattern, given that few if any candidate groves possess relatively low murrelet habitat quality along with high timber value, the type of data that would have prompted a convex shape in the tradeoff curve.

Turning to Figure 2, the tradeoff curve for the C/E ratio was relatively steep for low values of BFI set aside and progressively flatter as BFI increased beyond C/E of 33. Each unit of timber volume set aside for C/E values below 33 contributes more cumulative habitat value than timber volumes set aside above C/E of 33, suggesting that beyond C/E of 33, setting aside additional sites would add less to murrelet protection. However, C/E is probably a more limited gauge of marbled murrelet nesting habitat value because it is based more on the geometry of a stand rather than its composition. The volume of old-growth redwood is probably a superior habitat quality measure. During the negotiating process, government scientists developed a "stand productivity index" that combined old-growth volume and C/E to create a combined measure of stand habitat quality. This is a measure that can also be used in the knapsack model framework.

The knapsack model offers no guarantee that a specific amount of habitat that is set aside will be sufficient to ensure the murrelet's long-term survival in the Headwaters Forest area. Population viability analyses are required to attempt to answer that question. However, this relatively simple optimization approach does fit the data that were available during the HCP negotiations. The results presented here were not, in the end, employed in determining the results of the final Headwaters HCP agreement. Nevertheless, the model provides a methodology that can explicitly balance socio-economic and environmental goals and identify non-inferior solutions, rather than relying on subjective judgment. As HCPs proliferate and come under increasing scrutiny (Thomas 2001), there should be a continuing need for such modeling techniques. Methods that can incorporate not just habitat considerations but also economic factors should be increasingly relevant as controversies over "takings" escalate.

(**Note**: For the reader's convenience, the preliminary negotiated solution of March 1998 is plotted in Figures 1 and 2. However, stand boundaries had changed by the time of that agreement, and more changes occurred by the time of the final HCP agreement of March 1999.)

Acknowledgements

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Book Review

Riding the Tiger: Tiger Conservation in Human-dominated Landscapes.
By J. Seidensticker, S. Christie, and P. Jackson (editors). 1999.
Cambridge University Press. xix + 383 pp. Illustrated.

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In spite of valiant conservation efforts on the part of Asian states beginning in the 1970s, the plight of the tiger remains a major global concern. Perhaps no other creature has evoked greater emotion on the part of humans in the form of entire literatures and mythologies and, in many ways, the great predator has shaped cultures across the southern half of the Asian continent.

It was in the Chinese Year of the Tiger that the Zoological Society of London, with funding from Exxon Corporation, sponsored a conference that brought together tiger experts from many Western nations and from 13 of the 14 tiger range states. Only North Korea, with fewer tigers than any other current range state, was not represented. Papers presented there and at a follow-up meeting in Dallas in 1998 were later edited into this impressive volume. Most impressive is the fact that many problems and solutions that transcend science alone are represented.

The volume is divided into three parts and 22 chapters, authored by 79 tiger experts worldwide, and the editors have done a masterful job of assuring well-written English prose. They also provide a brief synopsis in the Preface of the problems later addressed. One look at the first figure tells much of the story. It is a map of Asia showing the estimated range of tigers in 1900 and at present, and the differences are striking. Gone are the tigers of Bali, Java, Central Asia, and the Middle East, and almost gone are those of China. In total, wild populations are now estimated at 5,000 to 7,000 animals, fewer that the numbers currently in captivity.

Part I, Introducing the Tiger, is comprised of four chapters. Chapter One sets the stage for establishing the major premise of tigers as predators of large ungulates, as ungulate conservation is a major theme throughout the volume. Chapter Two discusses in detail aspects of phenotypic variation in tigers further explored in Chapter Three with a molecular assessment of subspecies. The eight putative subspecies of tigers previously recognized are considered here to represent clinal variation and thus not true subspecies; the evidence suggests that tigers are too genetically close to warrant distinction and that tiger range has been contiguous across Asia during the past 10,000 years. Part I concludes with an essay by co-editor Peter Jackson on tigers and the human consciousness that addresses how the cultural importance of this animal can be used for conservation solutions. Jackson's final words reflect the mood of the entire volume: "if the tiger is saved, it will ensure the maintenance of healthy natural ecosystems, not just for tigers, but for everyone."

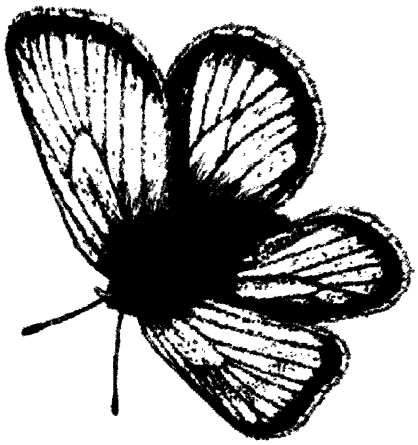
Part II contains nine informative chapters devoted to the more scientific aspects of tiger conservation, including ecology and landscape patterning. Separate chapters consider the status of the Amur tiger (Russian Far East), Bengal tigers in several Indian parks and throughout remaining range in Nepal, Sumatran tigers, and Indochinese tigers throughout Southeast Asia. These chapters collectively present cogent summaries of programs tying management in selected parks to broader views of conservation across large landscapes. A good overview of the methods of modern research in wildlife conservation is interwoven throughout. In all cases, the graphics are of high quality and informative.

After reading Part II, non-experts may ask, given that we have the scientific knowledge needed to conserve tigers and there are many good people working on the problem, why are tigers still in peril? This conundrum is addressed across the nine chapters in Part III, Approaches to Tiger Conservation. The modern axiom that science alone is not enough to address major conservation issues is inherent throughout these chapters, which consider human issues that lead to difficult conservation problems. Three full chapters are devoted to trade in tiger parts, and what to do about it. The news throughout the 1990s was particularly bad, but there is evidence presented here that suggests anti-poaching strategies are working and that wild populations are not being depleted as quickly as they were from 1990 to 1995. Both Russia and India have greatly increased anti-poaching efforts, and trade in tiger parts in consumer markets is showing signs of de-

cline. There is still no reason to be particularly optimistic at this point, but the trend is now in the right direction (at least). Five chapters in Part III consider human endeavors in available tiger habitat. They are quite far-reaching in their collective look at habitat protection in the context of broader landuse planning, and in integrating compatible human uses around tiger reserves. Noteworthy cases presented here come from India, Nepal, and the Russian Far East, but Thailand, Malaysia, and Indonesia are also making great strides.

Information from some areas that contain tiger habitat (e.g., Myanmar, Cambodia, Vietnam, and Laos) is still incomplete, and tigers are gone from many places. Researchers and law enforcement have to remain vigilant if wild tigers are to last through the 21st Century. None-the-less, the information presented here is more optimistic than that available only a few years ago. Some of the poorest nations on earth are making major advances in tiger conservation, and some of the richest corporations are now supporting them. The lessons are valuable to conservationists worldwide. If anything, Asia is ahead (in the developing world) in conservation programs partly because it was ahead in the depletion of natural habitats and species. Tigers, after all, share their range with half of humanity and, if tigers can be saved, this bodes well for jaguars, snow leopards, and other large carnivores that occur in comparatively sparsely populated regions. It bodes even better for myriad other smaller, more obscure, and energetically less demanding creatures. All of us in conservation are thus, in a sense, 'riding the tiger,' and we all have something to learn from this volume.

FOCUS ON NATURE ™ *by Rochelle Mason*



The **MISSION BLUE BUTTERFLY** (*Icaricia icarioides missionensis)* measures only 1 to 1 3/8 inches in length. The male flaunts iridescent violet-blue upperwings while the female is discreet in mostly brown. Underwings are off-white with spots. This endangered insect feeds on perennial lupines in coastal and montane habitat on the San Bruno Mountain and in the Marin Headlands in northern California. Eggs laid on these lupines hatch into larvae (caterpillars) which over-winter half-grown. Pupating in a chrysalis for a few weeks, the larva emerges as an adult butterfly in the spring to reproduce and live for about one month. Introduced plant species are squeezing out the native lupines necessary for this butterfly's survival. You can help ensure the quality and quantity of butterfly habitat by donating your time or money to a nature conservation organization. *www.rmasonfinearts.com. (808) 985-7311*

Marine Matters

Clean Water Protects Coral Reefs

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This past September in Florida, Key West city officials held a ribbon-cutting ceremony to inaugurate one of the most advanced wastewater treatment facilities in the southern United States and Caribbean. The new water treatment plant treats waste to advanced standards, removing harmful nutrients that threaten the surrounding coral reef ecosystem. The plant also features a 3,280 foot deep injection well that will end the discharge of treated sewage into the Atlantic Ocean, although a feasibility study is underway to determine if the highly-treated effluent can be reused.

The effort is the culmination of an accelerated $67.3 million dollar project to replace the island's 46 miles of main sewer lines and 27 miles of lateral sewage collection pipelines with new PVC pipe. Some of the iron, steel, and clay pipes date to the 1800s. In addition, almost all of Key West's septic tanks and cesspits have been eliminated. The plant improves the biological treatment process by adding filtration to remove nutrients.

Reef Relief, a Key West-based non-profit grassroots organization dedicated to protecting coral reefs, has worked with city officials for years to build public support for the effort to upgrade sewage treatment. Eighty-two percent of voters approved a referendum to hike sewer bills and provide bonds to finance the project. Thereafter, state and federal funds were obtained to reduce the overall cost, and now local sewer bills have been reduced to pre-construction levels. The city is now busy mounting an effort to upgrade the treatment of stormwater. These are the most important steps that the city could take to improve water quality to protect the fragile coral reefs of the Florida Keys.

Florida's coral reef ecosystem

The coral reef of the Florida Keys is North America's only living coral barrier reef and the third longest coral barrier reef in the world. The reef extends for 128 miles, from North Key Largo to the Dry Tortugas, and contains fish, stony and soft corals, sponges, jellyfish, anemones, snails, crabs, lobsters, rays, moray eels, sea turtles, dolphins, sea birds, and other sea life. Coral reefs are the most biologically diverse marine ecosystems on earth, rivaled only by tropical rainforests. Florida's coral reefs are home to more than 150 species of tropical fish and 50 species of coral, representing over 80 percent of the coral species in the tropical western Atlantic. Coral reefs have existed for 200 million years and reached their current level of biodiversity 50 million years ago. They are the oldest, most complex ecosystem in the sea.

The coral reef ecosystem is a delicately-balanced interdependent marine environment comprised of coral reefs, mangroves, and seagrasses. Each depends upon the health of the other to survive. Together with the upland hardwood hammocks, this ocean wilderness provides habitat for one-third of Florida's threatened and endangered species (Table 1). The Florida Keys are also home to several Species of Special Concern (Table 1). The destruction of North America's only living coral barrier reef poses a direct threat to parrotfish (*Scaridae spp*) and many other unique marine species that depend upon the reef ecosystem.

The health of these reefs has declined dramatically in the past fifteen years. A combination of factors is responsible, among them heavy use and physical damage from boats, anchors, divers, snorkelers, and fishing gear; loss of habitat from coastal development; declining water quality (especially an overabundance of nutrients); global climate change; and natural storm events. There has been a significant loss of coral species. From 1996 to 1999, stony coral cover decreased 38% on average in the 160 stations sponsored by the U.S. Environmental Protection Agency's (EPA) Florida Keys Coral Reef Monitoring Program, according to Dr. James Porter, lead investigator of the survey. The survey also has detected an early exponential increase in diseased corals and the appearance of new diseases throughout the Keys. This large scale, well-funded survey was the first to deliver irrefutable data documenting the decline of the Keys' coral reefs.

In order to heighten awareness of this decline, beginning in 1993, Reef Relief conducted a low tech Photo Monitoring Survey that led to the discovery of new coral diseases and documented significant coral loss due to disease, storm damage, bleaching, nuisance algal blooms, and boat groundings. Visibility has dropped

from "gin-clear waters" in years past to an average of 30 feet. Sewage and stormwater pollution from the Keys, agricultural runoff from the Everglades, and poor water quality in Florida Bay deliver harmful nutrients and pesticides to the reefs downstream. Storms, accidental boat groundings, and heavy sedimentation add to the multiple stressors that severely compromise the coral reef of the Florida Keys.

Socio-economic significance

Although the Florida Keys coral reef is only one-tenth the size of Australia's Great Barrier Reef, it is visited by ten times more people annually. They all come to enjoy North America's only living coral barrier reef and the tropical island environment of America's Caribbean islands. The residents of the Keys depend upon the reef for tourism, commercial and sport fishing, and protection from storm surge. The Keys generate a $2.5 billion annual economy by playing host to 4.5 million tourists who dive, fish, and boat in the Keys. In 1990, the hospitality industry (restaurants, catering, hotels) accounted for about one-third of Monroe County's $1.6 billion in total sales and business. During the year 2000, 275,380 people flew into Key West Airport with additional visitors driving down the overseas highway and still more arriving by boat.

To ensure the continued strength of the tourism industry, more than $9 million is raised annually by a county bed tax that is used for advertising to attract more visitors to the Keys. Marine-related industries account for almost five percent of total sales and business (1990 data). In addition to many nearshore commercial charter, diving, and fishing operations, the Florida Keys are the southernmost link of the United States to the Caribbean basin, a major conduit for offshore freighter and cruise-ship traffic. These warm Gulfstream waters have become a favorite cruiseship route, with stopovers in Key West. During the month of December 2000, for example, Key West hosted 70,000 cruise ship passengers, according to the Key West Chamber of Commerce. Plans are underway to expand cruiseship facilities due to the acquisition of the former Truman Annex Navy Base by the city of Key West.

Institutions

Jurisdiction over the coral reefs of the Florida Keys is a mosaic of local, state, and federal agencies. Monroe County is comprised of a string of islands with various local government jurisdictions overlaid with state and federal agency mandates. Municipalities in the area are the cities of Key West, Marathon, and Key Colony Beach, as well as the Village of Islamadora. Each municipality has a mayor and a board of commissioners, and Monroe County has a Board of County Commissioners. The municipal county components form the local government.

The Florida Keys National Marine Sanctuary Program is the principle authority for marine environmental protection. The sanctuary is a partnership with the State of Florida, whose jurisdictional waters include much of the sanctuary. Other important agencies with some mandate over reefs, shoreline, and water quality are the Florida Department of Community Affairs, the Florida Department of Environmental Protection, the U.S. Interior Department, and the U.S. EPA. Several national and local non-governmental organizations (NGOs), in addition to Reef Relief, are involved in marine and environmental conservation in the area. This large number of decision makers complicates any policymaking and tends to frustrate the local citizenry.

The Clean Water solution

Coral reefs require clear, clean nutrient-free waters to thrive. We are beginning to reverse the combination of impacts that reduce biologic diversity. A balance must be struck so that the Florida Keys can achieve and maintain healthy coral reefs that enhance and support an ecofriendly tourist economy. Many newcomers — residents and visitors — lack an understanding of the importance of protecting mangroves, seagrasses, and endangered species such as sea turtles, nor do they realize the negative impacts of marine debris, anchoring on coral, inadequate sewage treatment, or inappropriate shoreline development adjacent to coral reefs. Although coral reefs are also under stress from global impacts, localized impacts are avoidable. Increasing awareness and support for things we can all do every day on a local level to protect coral reefs is a primary goal of Reef Relief.

As noted in a recent study by the USEPA Water Quality Protection Program, "[s]ince maintenance of healthy natural communities of the Keys is dependent on low nutrient environments, localized sources of nutrients can have immediate negative impacts that can result in cascading effects throughout the ecosystem. Indeed, the main factors in the demise of coral reefs are human pressures, such as eutrophication and sediment loading" (Kruczynski 1999). Dubinsky and Stambler (1996) concluded that "human impacts on coral reefs are on a local and regional scale, rather than global impacts (excluding global warming and increases in ultraviolet light)." The study also concluded that, "[t]he survival of the existing Florida Keys marine ecosystem is dependent upon clear, low-nutrient waters."

The Key West Sewer Outfall was the largest point source of pollution in the Keys. Due to the new sewer line construction, it reduced daily discharge from 9.5 to five million gallons of waste. National Oceanic and Atmospheric Administration (NOAA)

and EPA studies documented that currents carried the effluent around the island. Beginning in 1999, Key West beaches were tested and health advisories posted when tests found levels of fecal coliform bacteria that exceeded state standards for safe swimming. The Keys were built on an ancient porous coral reef, with tidal flushing occurring through the limestone just three feet below the surface. Salt water infiltrated the sewer lines, and 40% of what was treated was salt water. This mixing violated state laws because of raw sewage discharges onto streets and into nearshore waters, especially during heavy rains.

At the urging of Reef Relief, the city of Key West has approved the addition of nutrient-stripping to achieve Advanced Wastewater Treatment (AWT) at the central sewage treatment plant. State laws are yet to acknowledge the low nutrient thresholds for coral reefs. Sewage contains nutrients, such as nitrates and phosphates, as well viruses and pathogens that are a public health threat to humans. Once released into the aquatic environment, increased nutrients, chemical toxins, and biological pathogens from sewage effluent can be responsible for algae blooms, coral reef and fish diseases, genetic defects in fish and wildlife, beach closings, and general environmental degradation. Corals can tolerate only small amounts of nutrients — one micromole of dissolved inorganic nitrogen and 0.1 micromole of soluble reactive phosphorus (Lapointe 1991).

Throughout the rest of the Florida Keys, sewage treatment does not meet this high standard. Over 25,000 septic systems are in use, many without bottoms, allowing sewage to leach into nearshore waters. Also, there are approximately 6,000 illegal cesspits, many in areas of intensive mobile home development on dead-end canals. In addition, package plants serving resorts, condominiums, campgrounds, and restaurants provide secondary treatment of waste that goes into 750 injection wells that discharge just 90 feet below the surface into the porous substrata of the Keys. Studies by Paul, Rose, Shinn, Griffin, and others (Paul et al. 1995a, 1995b, 1997) have documented that this injected waste reaches nearshore waters in as little as three to eleven hours, and in other instances within a week.

COMMON NAME	BINOMIAL NAME	STATUS
Reptiles		
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
leatherback sea turtle	*Dermochelys coriacea*	Endangered
green sea turtle	*Chelonia mydas*	Endangered
hawksbill sea turtle	*Eretmocheyls imbricata*	Endangered
American crocodile	*Crocodylus acutus*	Endangered
key mud turtle	*Kinosternon baurii*	Endangered
Birds		
least tern	*Sterna antillarum antillarum*	Endangered
piping plover	*Charadrius melodus*	Threatened
wood stork	*Mycteria americana*	Endangered
American peregrine falcon	*Falco peregrinus anatum*	Endangered
Florida grasshopper sparrow	*Ammodramus savannarum floridanus*	Endangered
bald eagle	*Haliaeetus leucocephalus*	Species of Concern
roseate spoonbill	*Ajaia ajaja*	Species of Concern
"Great white" heron	*Ardea herodias*	Species of Concern
osprey	*Pandion haliaetus*	Species of Concern
Insects		
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	Endangered
Snails & Molluscs		
Stock Island tree snail	*Orthalicus reses reses*	Threatened
queen conch	*Strombus gigas*	Species of Concern
Mammals		
Key Largo cotton mouse	*Peromyscus gossypinus allapaticola*	Endangered
Key Largo woodrat	*Neotoma floridana smalli*	Endangered
silver rice rat	*Oryzomys palustris natator*	Endangered
Lower Keys marsh rabbit	*Sylvilagus palustris hefneri*	Endangered
Florida Key deer	*Odocoileus virginianus clavium*	Endangered
Florida manatee	*Trichechus manatus latirostris*	Endangered
bottlenose dolphin	*Tursiops truncatus*	Species of Concern

Table 1. Endangered, Threatened, and Species of Concern in the Florida Keys.

A master wastewater plan has been approved for the county, but a recent state work group (of which Reef Relief was a participant and a dissenter) has concluded that standards for sewage treatment should be reduced from advanced wastewater treatment because on-site technologies that can meet the standard do not exist. AWT is a standard of 5:5:3:1 that includes nutrient stripping. Yet, as Key West has proven, alternative technologies do exist. AWT removes harmful nutrients from the waste that, once injected, may lack confinement and rise up into local waters. Nutrient removal has been practiced for nearly three decades. By State statute, AWT facilities are required in two locations in Florida, Tampa Bay and Indian River Lagoon (Kruczynski 1999).

The Monroe County Commission recently has approved a plan to provide AWT, central sewage to all residents of Key Largo. However, the project has been challenged on the grounds that the private meetings of the technical advisory panel that selected the low bidder were in violation of the Florida Sunshine Law. Many community members are wary of the proposal, and community support is needed to select a site, fund the project, and implement the plan within a reasonable time period. More importantly, county leadership is needed to support the effort. The V illage of Islamorada recently has approved funds for the design of an advanced wastewater plan, and an EPA-funded pilot project is underway for the Little Venice area of Marathon.

Not all sewage pollution originates from the land base of the Keys. The EPA has approved a request to create a No Discharge Zone for boater sewage in Key West waters so that live-aboard boaters and the world's largest charterboat fleet do not continue to dump into the ocean. The designation has been initiated by Reef Relief and announced in November, 1999. Reef Relief has designed an educational campaign, has helped spread word of the locations of pumpout facilities, and has held a contest that resulted in the slogan, *Pump It. Don't Dump It.* Compliance is encouraged in cooperation with the sanctuary, state, and federal agencies. Reef Relief members in the Keys distribute *Pump It. Don't Dump It.* mutlilingual informational brochures and signs, and radio announcements are still being aired. Efforts are underway to extend the designation Keys-wide. The designation is needed because although it is against federal and state law to discharge sewage into the sea, many vessels routinely use the ocean as a dumping ground instead of using available dockside or mobile vessel pump-out facilities when in port. Nearly 500 vessels dock at marinas and 128 vessels are moored or anchored around Key West alone, with many more throughout the Florida Keys, not including the numerous transient or seasonal vessels. Many are charterboats taking visitors to dive and fish, or to simply enjoy the water. State funding from the Boating Improvement Fund has facilitated the installation of additional onshore facilities in the Keys to pump out sewage, but more are needed.

These efforts and more will combine to improve water quality at the Florida Keys coral reefs. The Key West example proves that by working together, we can make a real difference for our coral reefs. This lesson will encourage island communities to take similar action to protect coral reefs around the globe.

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News from Zoos

African "Eden" Saved from Logging

The Minister of Forestry Economy of the Democratic Republic of Congo (DRC) recently announced the protection of what scientists herald as Africa's last existing "Eden." Goualogo Triangle, a 100-square mile rain forest, is home to some of the highest densities of gorillas, chimpanzees and forest elephants in central Africa. Joined by officials from AZA member Wildlife Conservation Society (WCS), Minister Henri Djombo stated that the area will be spared from logging by CIB – a private logging company. CIB also gave up its legal right to harvest the virgin forest in the name of conservation. Instead, the DRC government will add the Goualogo Triangle to the already existing Nouabale-Ndoki National Park, which WCS helped create in 1993.

This pristine forest will go untouched thanks in part to the Bronx Zoo's Congo Gorilla Forest exhibit. His Excellency President Dennis Sassou Nguesso of DRC first discussed the possibilities of protecting the Goualogo at the Zoo during his visit last September. Following that visit, the DRC held further deliberations with CIB concerning the joint CIB/WCS biological surveys (where were conducted to establish intensive regional wild populations) and the economic ramifications of protecting the area. WCS's recommendations to preserve the Goualogo came as a response to increasing pressure to develop and harvest the forest for timber. For the past several years, WCS and CIB have worked to improve forest and wildlife management in logging concessions and "buffer zones."

To draw attention to the plight of greater Congo River Basin rainforest ecosystem, the Zoo opened the exhibit in 1999, which has already provided invaluable education to millions of visitors. It has also raised more than $2.5 million from its admission fees, which goes directly to WCS's field programs in central Africa. [Source: AZA Communique]

Condor Breeding at Oregon Zoo

On 19 October 2001, Interior Secretary Gale Norton announced that the Oregon Zoo was accepted into the US Fish and Wildlife Service's California Condor Recovery Program. The Oregon Zoo also announced that the Metro Council has set aside 12 acres in its Clear Creek Canyon property for the zoo to use as one of the nation's four California condor breeding sites. Other breeding locations include the Los Angeles Zoo, the San Diego Wild Animal Park – both American Zoo and Aquarium member institutions – and the World Center for Birds of Prey in Boise, Idaho.

In 1987, the Department of the Interior brought the extant, wild population of 17 California condors into captivity. Today, there are 183 condors, of which more than 50 have been released back into their natural habitat. Zoo officials are expecting several pair of breeding condors as soon as next fall to start producing eggs the following spring. Before then, they must build a flight cage and several breeding pens. [Source: The Oregonian, Laura Oppenheimer]

New Wildlife Preserve in Papua New Guinea thanks to Roger Williams Park Zoo

Roger William Park Zoo announced on 14 December 2001 that a 50,000-acre wildlife preserve had been established on the Huon Peninsula of Papua New Guinea (PNG). The zoo hopes that someday the reserve will be as large as 150,000 acres. Dr. Lisa Dabek, the zoo's Director of Conservation and Research, was the major force behind establishing the reserve. She has traveled and researched extensively in PNG and is an expert on the Matschies tree kangaroo. The tree kangaroo is one of the species that will be protected in the preserve.

After becoming established in PNG, Dr. Dabek was introduced to Mambawe Manauno, a local landowner. He was starting to become concerned regarding the disappearing forests and animals near his village. Many of the people in Manauno's village were concerned about the idea of starting a wildlife preserve, but eventually, the villagers became convinced that the preserve was in their best interest. Since most of the land in PNG is in private hands, this type of approach, which involves participation by traditional landowners, will be critical for pursuing conservation goals in PNG. The next step for the preserve is to have the PNG government formally register the preserve as a wildlife management area. [Source: Providence Journal, Karen Lee Ziner]

Information for News from Zoos *is provided by the American Zoo and Aquarium Association*

News & Events

National Wildlife Federation 2002 Species Recovery Fund

Applications are now being accepted for National Wildlife Federation's 2002 Species Recovery Fund (SRF). The fund was created to spur habitat restoration efforts, species reintroduction projects, and other creative endeavors that will directly improve conditions for the endangered species featured in the Federation's *Keep the Wild Alive* campaign. Priority is given to projects that also incorporate a public outreach component and can be easily replicated.

In 2002, the Keep the Wild Alive campaign will award approximately ten grants — each between $3,000 and $7,000 — to organizations, individuals, agencies, tribes and universities. The deadline for applications is February 15, 2002. A list of species that are eligible for funding, descriptions of projects that received SRF monies the past two years, and grant guidelines are available at: www.nwf.org/wildalive. For more information, contact YinLan Zhang at (202) 797-6892, or send email to zhang@nwf.org.

Botanical Symposium

The 2002 Smithsonian Botanical Symposium, entitled "The Convention on Biological Diversity: The Globalization of Natural History Science," will address the impact of the Convention on Biological Diversity on scientists and its ramifications for understanding the natural world. The symposium will be held April 5-6, 2002 in Washington DC at the National Museum of Natural History. For more information contact Dr. W. John Kress: (202) 357-2534; kress.john@nmnh.si.edu; or visit <http://persoon.si.edu/sbs/>.

'Extinct' Tree Rediscovered

In April, *Trochetia parviflora*, a small, attractive tree found only on Mauritius, was rediscovered by Vincent Florens and Jean-Claude Sevathian. The Mauritian plant, last seen in the wild in 1863, was found clinging to a rocky slope in the Corps de Garde Mountain Nature Reserve, six km from the nearest area in which it was previously known. The scientists have since intensified their search and have now found 63 plants. Approximately 27% of Mauritius' native species are considered to be threatened.

Announcements for the Bulletin Board are welcomed. Some items have been provided by the Smithsonian Institution's Biological Conservation Newsletter.

Endangered Species UPDATE

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