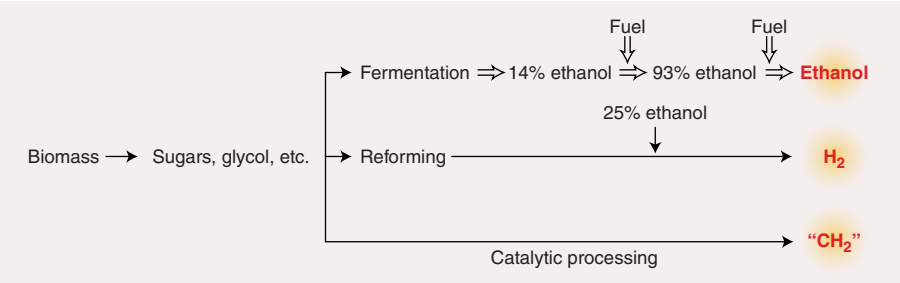

Process routes for conversion of carbohydrates to fuels. These routes include ethanol via fermentation and distillation (**top**), hydrogen via ethanol or directly by liquid-phase steam reforming (**middle**), and hydrocarbons ("CH_2") by the process described by Huber *et al.* (*1*) (**bottom**).

Now, Huber *et al.* (*1*) raise the question why one should not make hydrocarbon fuel directly, instead of aiming for hydrogen as a fuel, which would require an expensive new infrastructure. Modern diesel engines are almost as efficient as fuel cell–driven cars that use hydrogen fuel are likely to be. Why not then make "sustainable" synthetic liquid fuels (synfuels) instead of hydrogen (*5*)?

The same question may be asked for a hydrogen society built on fossil fuels and sequestration of carbon dioxide. Fossil fuels may be converted by gasification or steam-reforming to synthesis gas (a mixture of carbon monoxide and hydrogen) (see the first figure). Carbon monoxide may be further converted to hydrogen and carbon dioxide; the latter may be reinjected in oil fields or in cavities (sequestration). Alternatively, the synthesis gas can be reacted to synthetic liquid fuels in the form of synthetic diesel or gasoline (synfuels) (see the first figure).

Automotive fuels (that is, diesel and gasoline) have an atomic hydrogen-to-carbon ratio, H:C, of 2 ("CH_2"). Ethanol can be converted to hydrocarbon fuel by catalytic processing over zeolites, but the conversion of carbohydrates faces a fundamental problem: Although carbohydrates ($C_nH_{2n}O_n$) contain a lot of hydrogen, this hydrogen is bound to oxygen, meaning that the "effective" H:C ratio is 0.

The earlier liquid-phase reforming method of Huber *et al.* (*4*) solves this problem by extracting oxygen as carbon dioxide, and then making hydrogen. Now, Huber *et al.* (*1*) show that the use of well-known organic syntheses makes it possible to convert carbohydrates into hydrocarbons that are of interest for use as fuels. The process scheme eliminates the expensive distillation process, because separation of the hydrocarbon product from the aqueous phase is simple. Although the reaction paths should be optimized and the cost of the process must still be analyzed and compared with alternative routes (see the second figure), the work of Huber *et al.* (*1*) shows how explorative work can create new options for the supply of energy.

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ECOLOGY

Rediscovery of the Ivory-billed Woodpecker

David S. Wilcove

A book on North American wildlife, published in 2000, scoffed at the notion that the ivory-billed woodpecker (*Campephilus principalis*) might still be alive somewhere in the southern United States: "Although it remains the Holy Grail of American birdwatchers, with persistent rumors of its presence in remote forests, most ornithologists now concede that it vanished from the United States sometime in the past 40 years…Its presence today in the sterile, industrial forestlands of the South, however wonderful a thought, would be as out of place as a buckskin-clad settler with a musket in the streets of modern-day Atlanta" (*1*). As the author of that book, I now know that sometimes it's great to be wrong. As reported by Fitzpatrick *et al.* on page 1460 of this issue (*2*), the ivory-billed woodpecker has been rediscovered in eastern Arkansas, its presence confirmed by multiple sightings and a grainy but diagnostic videotape. The rediscovery stunned birdwatchers and generated headlines around the world. But those not under the spell of this charismatic species might well wonder what all the fuss is about. What is the ecological significance of the ivorybill's reappearance?

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The outlook for the species is uncertain. Fitzpatrick *et al.* did not find any breeding pairs in 14 months of nearly continuous field work, and they concede that all of their observations may refer to a single individual. Ivorybills naturally occur at very low densities. J. Tanner, who undertook the only field studies of the species in the late 1930s (*3*) estimated the density of ivorybills to be no more than 1 pair per 16–44 km^2 of suitable habitat. This characteristic, combined with the degraded condition of the current habitat and the paucity of sightings, suggests that any breeding population must be extremely small, perhaps only a few pairs. Such a tiny population would be highly vulnerable to stochastic extinction processes. Other North American birds, however, have rebounded from remarkably low numbers. The whooping crane (*Grus americana*) population was down to 14 adult individuals in 1938 (*4*); today, it exceeds 200. No more than 7 Laysan ducks (*Anas laysanensis*) survived in 1912 (*5*); the current population is ~500. Also, given the ivorybill's apparent dependence on old forests (*3*) (see photo), the passage of time should result in more and better habitat for the woodpeckers, as second-growth forests age.

Events preceding and following the ivorybill's rediscovery illustrate the relative benefits of two different approaches to conservation. The Cache River National Wildlife Refuge, where Fitzpatrick *et al.* made their discovery, was established in 1986 with the transfer of 154 ha from The Nature Conservancy, a private nonprofit conservation organization, to the U.S. Fish and Wildlife Service. Subsequent land-acquisition efforts by The Nature Conservancy and

the federal government increased the refuge's size to ~22,300 ha (*6*). At the time the land was acquired, no one was anticipating the discovery of ivory-billed woodpeckers. Conservationists valued the area for its concentrations of wintering waterfowl and as an example of the swamp and bottomland hardwood forests that once dominated millions of hectares in the southeastern United States. The discovery of the ivorybill within the refuge's borders validates the wisdom of conserving representative examples of all types of ecosystems, regardless of whether they contain known populations of imperiled species. Such preservation can act as a "coarse filter" for protecting little-known or overlooked species (*7*).

Yet the documented presence of an ivorybill has resulted in an outpouring of support for conservation efforts in the region. On the day the bird's discovery was announced, for example, the U.S. Departments of Interior and Agriculture pledged $10 million for efforts to protect the ivorybill and its habitat. Unless these departments receive increased appropriations, that money will have to be taken from other worthy projects, presumably ones that lack a species as charismatic as the ivorybill, thereby demonstrating the value of a flagship species in generating support for conservation.

Still hanging on in the woods. The Singer Tract in Louisiana, where this 1935 photograph was taken, was logged during World War II, but bottomland forests are now regenerating across the ivorybill's ancestral range.

The resurrection of the ivorybill also raises an intriguing question: If a bird last sighted decades ago can return from the dead, might we be too hasty in writing the obituaries of other species? Indeed, the case of the ivorybill, while astounding, is not unprecedented. The black-hooded antwren (*Formicivora erythronotos*), for example, was rediscovered in southeastern Brazil in 1987 after more than 100 years without a sighting; the New Zealand storm-petrel (*Oceanites maorianus*), last recorded in the early to mid-19th century, was refound in January 2003.

Not surprisingly, environmental skeptics seize upon events such as these to question the prevailing opinion among ecologists that the world is facing an impending anthropogenic extinction crisis (*8*). Estimates of contemporary extinction rates are based largely on calculations relating the number of species to the amount of suitable habitat; as the amount of habitat decreases owing to human activities so, too, will the number of species. Considerable uncertainty surrounds the timing of this relationship. If small, isolated populations are indeed prone to extinction but disappear slowly, then rediscoveries of supposedly extinct species do not necessarily invalidate extinction predictions. Instead, such events offer a ray of hope for conservationists: If sufficient amounts of habitat can be restored (a big "if"), perhaps the loss of these species can be averted. Time is of the essence, however. A recent report from BirdLife International found that the status of most of the world's threatened birds continues to deteriorate (*9*).

Finally, the good news about the ivorybill should not obscure the bigger, uglier picture of avian extinction in the United States. No nation has lost more species of birds in the past 25 years than the United States, largely as a result of recent extinction events in Pacific islands (see the table). It would take multiple rediscoveries nearly as miraculous as that of the ivorybill to alter this shameful fact.

RECENTLY EXTINCT U.S. BIRDS

Species	Last sighting	Reference
Olomao (*Myadestes lanaiensis*)	1980	(*10*)
Mariana mallard (*Anas oustaleti*)*	1981	(*11*)
Guam flycatcher (*Myiagra freycineti*)	1983	(*4*)
Kamao (*Myadestes myadestinus*)	1985	(*10*)
Oahu alauahio (*Paroreomyza maculata*)	1985	(*10*)
Kauai oo (*Moho braccatus*)	1987	(*10*)
Dusky seaside sparrow (*Ammodramus* [*maritimus*] *nigrescens*)†	1987	(*12*)
Ou (*Psittirostra psittacea*)	1989	(*10*)
Poouli (*Melamprosops phaeosoma*)	2004	(*13*)

*Disputed species, not recognized by American Ornithologists' Union. †Considered a subspecies of *Ammodramus maritimus* by American Ornithologists' Union.

Birds native to the United States that have become extinct since 1980. One additional species, Hawaiian crow (*Corvus hawaiiensis*), is now extinct in the wild but survives in captivity.

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