tion of Birds in the United Kingdom, for instance, has a membership of 890,000, making it the biggest wildlife conservation organization in Europe. The Greek equivalent, the Hellenic Ornithological Society, has 500 to 1000 members.

As a result of this history of activism, many sensitive areas in the north are already protected. In Denmark, for example, "the total area of protection is expected to increase by only 1%, from 7% to 8%," says Claus Goldberg, a biologist in the ecology division of the Danish Ministry of Environment and Energy.

There are, therefore, questions about the relevance of the Habitat Directive troubling the north. The Dutch, the original champions of the directive, were expected to release their proposed listin April, but the government is still reviewing it. Case Lancaster of the Netherlands Society for Nature and the Environment says the Dutch are already doing a great deal of work on the development of a national ecological strategy. And this strategy, unlike the Habitats Directive, is geared toward developing new habitats as well as protecting pre-existing ones: The Dutch have been trying to craft new habitats from agricultural land, because little undisturbed land is left. The Dutch goal of developing Europe-wide conservation measures has left it with a directive that adds little to its national effort. "The directive is likely to cover some new sites, but it won't do much to improve management of Dutch habitats," says Thissen.

A directive for the future? Diana admits the directive faces a raft of problems. But it has full legal backing, and there is the possibility of financial penalties for member states failing to comply with its requirements through the European Court in Luxembourg, he says: "These penalties have not been used so far, but they could in the future." He doesn't anticipate having to make good on this threat, however, saying that countries will fall into line, given enough time to complete their biological surveys.

But other observers are not as sanguine, particularly on the issue of whether governments, when push comes to shove, will protect habitats over development needs. "Politicians are often willing to pay for more research, but they have so far ducked the issues of conservation in favor of development policies," says Lawton. "There's no evidence governments have undergone a fundamental shift in the way they assess these conflicts of interest." As the battle for the bustards looms and other species are threatened, "it will be impossible to present a complacent picture," says David Baldock, deputy director of the Institute for European Environmental Policy in London. "It will be increasingly clear we still haven't got things right."

–Nigel Williams

BIOLOGICAL SURVEYS

In Hawaii, Taking Inventory of A Biological Hot Spot

As far from any continent as it's possible to get, the Hawaiian islands have cradled a selective assortment of the world's biota. Early in their history, the islands held no mosquitoes, no cockroaches, no snakes, no frogs, no animals larger than a bird. The animals and plants that did manage to wash or blow ashore transformed the rugged volcanic terrain into habitat for a globally unique biota. They launched some of the planet's most explosive examples of adaptive radiation, as new species evolved from the founding stock. Hawaii boasts a quarter of the world's species of the fruit fly *Drosophila*, well over 600 species which are believed to have descended from one or two original wandering groups. Before human settlement, according to the fossil record, the islands supported at least 47 species of honeycreepers, birds with bills of widely disparate shapes, that all evolved from a single finch species. As a living lab to test theories of adaptation and evolution, Hawaii has no parallel.

More recently, Hawaii has acquired a less distinguished reputation as a hotbed of extinction—only 20 of the honeycreeper species remain, for example, most of them at risk as their habitat falls before urban expansion or is invaded by harmful or competing exotic species, a particularly severe problem for Hawaii. Weeds not native to the islands, destructive feral goats and pigs (brought to Hawaii by James Cook and others), and exotic birds that compete for resources or carry avian diseases can invade even protected tropical forests and threaten the survival of remaining native species.

Now, because of its evolutionary value and concern for its conservation, Hawaii's biota is gaining yet another point of distinction: It is the subject of the most detailed biological survey ever attempted for a single biogeographic area. "[This] is the first time this has been done for any area approaching the diversity of Hawaii," says entomologist Scott E. Miller, head of natural sciences at the Bishop Museum in Honolulu. Authorized by the state legislature in 1992 and funded with a $260,000 start-up grant from the John D. and Catherine T. MacArthur Foundation, the museum staff and outside collaborators are producing a database of all Hawaii's known species and their habitats and biology. Already the effort, which is based on scientific literature, museum collections, and fieldwork, has begun to pay off: Investigators have found that some species thought to be rare or even extinct, such as certain damselflies, are still hanging on in odd pockets of land.

Biologists elsewhere are hailing the effort, saying that it should help Hawaii chart conservation strategies, yield new insights into the global species total, and test methods for larger scale biological surveys. Says tropical biologist Thomas E. Lovejoy of the Smithsonian Institution in Washington, D.C.: "This is a test of the value of collection-based data. I'm confident of the value it will have."

JACK JEFFREY

Unexpected find. Hawaii's biological survey turned up the rare orange-black damselfly in a surprising place: a building construction site.

Researchers conducting the Hawaii survey began by scouring the literature for all citations for a particular group, such as ferns. Unpublished sources (from government biologists or conservation groups, for example) were consulted as well. From the results, the Bishop staff has gleaned a list of all the species ever spotted in Hawaii and is standardizing the names and descriptions. (Historical terminologies sometimes conflict with current ones.) The researchers are combining the lists of Hawaiian species to create a massive new database* that not only contains a bibliography of all the research articles on a particular species but also lists the specimens of that group housed in the museum's collections. The contents of other museums' Hawaii collections are to be linked to the database as well. Once all the existing information on a species is amassed and assessed, biologists can begin to identify gaps in the database, noting species that haven't

* The Bishop Museum's database can be reached on the World Wide Web at http://www.bishop.hawaii.org

been adequately described scientifically or haven't been searched for in all the likely habitats. The museum is beginning to commission new field research and other studies to fill these gaps.

Overall the effort has so far yielded a total of 21,368 species on the islands and in surrounding waters, including plants, animals, fungi, algae, and other protists (but excluding bacteria and viruses). Of the total, more than 4250 are established species from outside Hawaii (exotic, or non-native) that were accidentally or intentionally introduced by humans, beginning with the Polynesian settlement some 1500 years ago, then accelerating in the 18th century with the European arrival and continuing today. This group includes rats, mosquitoes, yellow jackets, weeds, and plants such as the strawberry guava that spread from gardens to become pests in the wild. The total does not include what Miller says are about 10,000 non-native cultivated species used in agriculture (pineapple and sugar cane, for example), ranching, and the substantial ornamental plant industry. Another 8767 of the known species are endemic, or unique, to Hawaii. Certain native terrestrial groups have an overwhelming number of endemic species: flowering plants (at least 80%); snails and insects (at least 95%), and birds (100%).

Coming up with species lists for some groups was a cinch—the islands had no amphibians or reptiles and only one native mammal species, a bat, before humans brought their pets, pests, and livestock, so lists for these groups involved only a few well-known species. Flowering plants and birds were fairly well documented before the survey. The data on fungi are perhaps the weakest, according to Miller; here scientists are barely past the literature-search stage. Field surveys and other research on these less studied groups are to be commissioned as funds and staff become available.

Along the way, the Bishop researchers have made some unexpected finds, including the discovery of species lingering in locales where they were believed to be extinct: Some of Hawaii's endemic brightly colored damselflies, a group related to dragonflies, are one example. The survey indicated a paucity of field data on the damselflies, so surveyors went looking. They found a colony of one species, the Hawaiian flying earwig damselfly (*Megalagrion nesiotes*), not seen for more than 70 years and considered to be extinct, less than half a kilometer from a major highway on Maui.

Another species, the Hawaiian orange-black damselfly (*M. xanthomelas*), was once common around streams throughout the lowlands but became prey for non-native fish introduced to control mosquitoes earlier this century. It had declined to the point of becoming a candidate for the federal endangered species list and was thought to have disappeared from the island of Oahu. But it turned up there on federal land slated for a hospital construction project, an urbanized site with none of the native habitat typically associated with the insect. "Nobody in their wildest imagination would have thought it occurred in this area," says zoologist Allen Allison, the Bishop Museum's vice president for research. The same resourceful damselfly species also turned up in another surprising spot—artificial ponds created for a resort on the island of Lanai.

"It may very well turn out as survey activity increases that many of the species thought to be threatened and endangered may actually be doing a lot better than we've recognized," says Allison. And that, he says, may allow for more latitude in their management. For instance, the discovery of damselflies at the artificial resort ponds is now providing researchers with a model to use in creating a new habitat for the hospital site population, which will be relocated to avoid a potential conflict with the construction project.

Some of the other known damselfly species, however, have not turned up in the field surveys, even at sites where the literature or museum specimens indicated they had been found earlier. These have been confirmed to be rare, if not extinct, species, according to Bishop entomologist Gordon Nishida.

On a larger scale, the results of the survey should bolster efforts to estimate biodiversity worldwide, says Stuart Pimm, an ecologist at the University of Tennessee, Knoxville, who has studied Hawaii's birds. Says Pimm, "A reasonable inventory of a particularly distinct region like Hawaii will be enormously valuable in giving us some order-of-magnitude estimates of how many species there are out there."

And the Hawaii effort may help pave the way for others. To be sure, the job is simpler on Hawaii than elsewhere, simply because it is an island chain with a relatively manageable number of species. A number of other states, such as Illinois, have ongoing biological surveys, but other states' lines don't define a whole ecosystem the way they do in Hawaii. "Our geographical boundaries coincide exactly with our political boundaries," says Allison.

Still, observers consider the Hawaii project a guide to how to proceed with a larger scale biological survey and what it can achieve. "For the country as a whole, it's a concrete model of what we'd like to have," says Missouri Botanical Garden Director Peter Raven, who also chaired the National Research Council committee that drew up guidelines for a U.S. national biological survey in 1993. Prospects for such a survey are now in doubt, however—the National Biological Service, chartered precisely to do such work, has run afoul of budget-cutters and states' rights movements in the U.S. Congress, who fear federal land seizures under the guise of accounting for and protecting national biodiversity (*Science*, 10 February, p. 780).

Then again, some of the country's, and the world's, rarest biodiversity is found in Hawaii: About a quarter of the species on the federal endangered species list inhabit the islands, even though they include just 0.2% of the U.S. land area. So the Bishop project—tiny though it is in comparison with a national survey—may do a key part of that accounting all on its own.

–Christine Mlot

SPECIES DIVERSITY IN HAWAII

Group	Endemic[1]	Non-Native[2]	Status Unknown[3]	Total Species
Algae and other protists	4	5	1724	1733
Fungi and lichen	240	0	1783	2023
Flowering plants	850	861	183	1894
Other plants	243	50	410	703
Mollusks	956	86	614	1656
Insects	5188	2543	175	7906
Other arthropods	319	482	962	1763
Other invertebrates	767	71	1317	2155
Fish	139	73	983	1195
Amphibians	0	4	0	4
Reptiles	0	18	0	18
Birds	60	46	168	274
Mammals	1	19	24	44
TOTALS	**8767**	**4258**	**8343**	**21,368**

[1] Species unique to Hawaii.
[2] Immigrant and purposefully introduced species.
[3] Insufficient research to make valid determinations.

SOURCE: L. G. Eldredge and S. E. Miller, *How many species are there in Hawaii?* Bishop Museum Occ. Pap. 41, pp. 1–18 (1995).

Taking stock of diversity. The Bishop Museum's species listing is the most complete inventory of Hawaii's biota ever done.

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