Protecting wildlife helps to sustain ecosystems and the services they provide, but beyond that, wildlife species have an intrinsic value. It is hard to imagine a world without iconic species such as the African elephant. However, elephants carry with them an appendage of great commercial value: their tusks. Conservation efforts struggle to keep pace with illegal takes by poachers fueled by the promise of great financial gain. On page 84 in this issue, Wasser et al. (1) provide an example of how modern technologies are making life harder for the poachers.

The effective conservation and management of wildlife is a complex and challenging problem, requiring detailed knowledge about the species, its environment, and the threats it faces. Conservation success sometimes comes from reduced anthropogenic pressures, such as the diminishing market for oil from northern elephant seals after hunting left this species too rare to sustain the industry (2). At the same time, legislation and enforcement are essential and were part of the process of recovery for the northern elephant seal, which is now protected in both Mexico and the United States. A dramatic and controversial example of success that relied heavily on enforcement was the essentially paramilitary approach of the Kenya Wildlife Service, sanctioned by the Kenyan government of the late 1980s, which reversed an epidemic of African elephant poaching in Kenya.

However implemented, enforcement and effective management rely critically on good information about the nature and extent of the human impact. For example, since the 1940s, the International Whaling Commission has set catch quotas and received catch level reports from participating countries. In 1993, a Russian official announced that catch levels by Soviet vessels had been grossly underreported for decades and that protected species (where the quota was zero) had also been taken (3). These activities negatively affected various species, and at least one struggles to recover (3). Permitted whale takes are now cataloged on genetic registers and commercial products are routinely checked, helping to reveal illegal catches when they occur (4).

However, a register on its own cannot address the problem of poaching directly. For that, illegal takes need to be identified and prevented—a very difficult task. In an exten-
sive program of crime scene identification, Wasser et al. now apply DNA typing to exactly this objective.

The crime is the renewed epidemic of elephant poaching across Africa. The problem is great. Tens of thousands of elephants are illegally killed every year and many tons of ivory seized by enforcement agencies (see the photo)—51 tons in 2013. As Wasser et al. note, that scale of known illegal ivory suggests a take of over 50,000 elephants that year, compared to an estimated 434,000 to 683,000 African elephants left in the world in 2012 (5). Consequently, populations are in decline (6), implying an extinction risk if poaching continues at this rate. Wasser et al. use DNA forensics on a continental scale to match seized hauls of ivory to the geographic locations of poaching activity. If accurate and sufficiently fast, these data could greatly enhance the potential for effective enforcement.

“Wasser et al.’s results allow the park systems where poaching occurs to be identified, thus providing local authorities with invaluable information toward more effective enforcement.”

There are two essential aspects to their method. First, the authors assessed the population genetics of the source populations by genotyping 1350 African elephants (including both savannah and forest elephants) from 71 locations across the range of the species. They then genotyped the seized materials and assigned individual genotypes back to putative source populations. These two aspects are interdependent and require accurate data and diverse genetic markers. Furthermore, there must be detectable genetic differentiation among geographic populations; otherwise, there will be no signal from which to identify sample origin. Forest and savannah African elephants are distinct at least at the subspecies level (7). For each, population-level differences provide the potential for good resolution, although the scale of population structure is fairly large in this highly mobile species (8, 9). By using the genetic data to assign reference individuals back to their known source populations, Wasser et al. demonstrate an accuracy of ~300 to 500 km for their method.

There is a devil in the details. Sampling large numbers of animals to build a full reference set of genotypes is difficult for wildlife species and often relies on noninvasive sampling—for example, from excrement—but this DNA may be quite degraded. The animal parts used to assign particular animals back to their source population also typically provide degraded or low-concentration DNA. However, there is good precedent for success with processed materials. For example, testing for illegal whale takes often involves processed meat (4), and shark species have been identified from fin soup and supplement pills made from shark cartilage (10).

All the same, careful controls need to be undertaken to take account of DNA degradation to ensure genotype accuracy. Some data may be lost when quality is insufficient. Wasser et al. provide a very useful analysis of this in their supplementary tables, where they show the proportion of loci not lost to quality control (often less than half) for the different sample sets. This has further implications because the resolution of population assignments depends on the level of information provided in the genetic screen; if loci are lost to quality control, assignments become less precise.

In many cases, Wasser et al.’s results allow the park systems where poaching occurs to be identified, thus providing local authorities with invaluable information toward more effective enforcement. Of course, the finer the resolution and the faster the result, the more likely it is that enforcement can result in prevention before the poachers move on to new pastures. Fortunately for wildlife, technology also moves on. It is becoming increasingly realistic and affordable to screen hundreds or even thousands of loci at once in an automated array system that works well with degraded DNA. For example, such a system has been developed to monitor wolf populations in Europe (11), achieving both high precision and fast turnaround times. The DNA forensics approach exemplified by Wasser et al.’s study can be extended with these further innovations and integrated with other effective approaches (6). Hopefully this will start to turn the tide for the African elephant and other threatened wildlife.

REFERENCES
5. www.elephantdatabase.org

ENZYMOLGY
It costs more than a nickel
Lactate racemase contains a complex nickel cofactor

By Deborah Zamble

Biology class teaches us that enzymes are proteins, but many enzymes rely on supplementary nonprotein cofactors for catalytic activity. Some enzyme active sites contain elaborate auxiliary components that provide chemical versatility well beyond the capabilities of naked proteins. Such enzymes often require a lot of extra effort to prepare, entailing synthesis and/or mobilization of multiple scarce components. On page 66, Desguin et al. (1) show that the catalytic center at the active site of lactate racemase contains both a prosthetic group derived from nicotinic acid (vitamin B3) and a nickel ion. This organometallic cofactor bears several features that have not been seen before in nature and raises questions about both the biosynthesis and the catalytic reactivity.

Although nickel is used by only a few enzymes, they cover a diverse array of chemical reactions (2–5). The first enzyme found to require at least one nickel ion cofactor was urease, which catalyzes the hydrolysis of urea into ammonia and carbon dioxide. Today, the list includes enzymes that produce or use carbon monoxide, acyl-coenzyme A, hydrogen gas, or methane, as well as several that provide protection from toxic by-products. Each of these nickel enzymes has a distinctive active site, and many include additional components or protein modifications.

Last year, Desguin et al. showed that lactate racemase (LarA) also uses nickel for activity (6). LarA allows microorganisms to metabolize either the L- or D-isomer of lactate. It can also produce n-lactate, which provides resistance to the antibiotic vancomycin when it is incorporated into the peptidoglycan layer of bacterial cell walls. In Lactobacillus plantarum, larA is in the multigene larABCDE operon (7), which is downstream of a second operon encoding a putative nickel membrane transporter (6, 8). Desguin et al. showed that nickel supplementation and several other Lar proteins are required to generate active LarA. Metal analysis indicated that two of these accessory proteins can bind nickel, and ac-
Can DNA foil the poachers?
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Editor's Summary

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