length for a fixed microwave amplitude, Chiorescu et al. traced out a series of damped Rabi oscillations with a decay time of about 150 ns. In two further experiments involving sequences of pulses, they obtained a decoherence time of about 20 ns and a relaxation time from the excited state of about 900 ns.

The flux qubit—the realization of Leggett’s original proposal—joins the charge and phase qubits as a means of observing the coherent superposition of two quantum states in a superconducting circuit. What happens next? A major issue for all three kinds of qubits is the source of decoherence. There are many candidates, including external flux noise, Nyquist noise currents in nearby metallic objects, inhomogeneous external flux noise, Nyquist noise currents, charge and noise in the motion of charge in traps, and noise in the measurement scheme. However, even with the available decoherence times, one could attempt to “entangle” two qubits. As a step in this direction, Pashkin et al. (10) have recently reported coherent mixing of quantum states by capacitively coupling two charge qubits. A classic example of entanglement is the simultaneous emission of two photons with zero net spin that move away in opposite directions: measurement of the spin of one photon predicts the outcome of a subsequent measurement of the other, no matter how far away. It would be fascinating to examine this action-at-a-distance—known as the Einstein-Podolsky-Rosen paradox (11) with superconducting circuits. Tests of quantum mechanics versus macroscopic realism may be within reach (12).

Entanglement is also necessary for quantum computation. Whether or not a large-scale quantum computer can ever be realized—with superconducting qubits or otherwise—remains to be seen, but in the meantime, the quest for it is likely to drive many beautiful experiments.

References

Overkill and Sustainable Use
Martyn Murray

For over two decades, the international conservation lobby has advocated economic development as the primary means of achieving sustainable living (1). This goal has proved elusive even when biological resources are controlled by local communities (2, 3). Nevertheless, many development agencies have accepted commercial incentives and regulations as the mainstay of their conservation effort (4), apparently without taking into account humankind’s long history of exploiting wild living resources. Consideration of episodes of overkill and sustainable use in human history may inform the prevailing conservation paradigm.

“Overkill”—a conspicuous decline in a population of hunted animals without prospect of stabilization or recovery—is often coupled with trade in animal products and wastage of less valuable parts of the carcass. It has been cited in the late Pleistocene extinctions of large mammals in Australia, New Guinea, and the Americas (5); the extinction of large flightless birds in New Zealand in the 14th century (6); the North American fur trade in the 17th and 18th centuries (7, 8); and the current harvest of wild meat from increasingly accessible tropical forests in west and central Africa (9).

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In contrast, sustainable harvesting ensures that wildlife populations remain numerically stable. It is usually assumed implicitly that hunters could kill at a higher rate if they so chose. Sustainable harvesting has been claimed in red deer stalking in the Scottish Highlands in the 19th and 20th centuries (10); the hunting of wildlife by Bushmen in the mid-20th century (11); and the hunting of game animals on private farmland in southern Africa in the late 20th century (12).

Onset of Overkill
Four triggers are commonly associated with unsustainable hunting: occurrence of naïve prey, vulnerable animals, new technology, and trade.

Naïve prey is believed to have played a key role when paleolithic hunters crossed the Bering land bridge in about 12,000 B.C. and spread across North and South America, all the while hunting native large mammals so effectively as to bring about their extinction (5). The hunters invading the Americas may have been more effective than those in Africa and Asia because their prey lacked awareness of humans as predators (13). Top predators and highly specialized species may be vulnerable to overexploitation because they reproduce slowly. Migratory animals may be at risk because of the perception that their populations are limitless. The northern Plains Indians believed that the bison herds disappeared each season to graze beneath the water on pastures where they bred in countless numbers (8). At the same time as the near extinction of bison, the passenger pigeon became extinct. One of John Muir’s characters remarks that “they were made to be killed, and sent for us to eat as the quails were sent to God’s chosen people” (14). Prey animals are also vulnerable if another primary source of food is available to their predator, allowing the latter to persist at high density even when its prey has been reduced. Hence, Australian marsupials are vulnerable to foxes, which have rabbits as their primary prey (15).

New technology is often incriminated in wildlife overkills. The extinction of Pleistocene mammals in Africa has been linked to the development of hand axe cultures (16). Soon after Europeans arrived in the Americas, Native Americans began trading pelts for guns and steel traps that contributed to the decline in large mammals. In Africa, wire snare set in lines are one of the most effective overkill technologies. Declines in freshwater and marine

ANTHROPOLOGY

Rock painting of a Bushman hunter from the Western Cape of South Africa.

Perspectives

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PERSPECTIVES

fisheries have followed the introduction of ever more sophisticated and indiscriminate fishing craft and gear.

Efficient technology also tends to divorce hunters from their prey by reducing, or dispensing with, the respect often found in the human-wildlife relationship of indigenous peoples (17). Among modern recreational hunters, this respect is reflected in the notion of sportsmanship, which disapproves of methods that kill easily or indiscriminately.

Powerful market forces are frequently implicated in the overexploitation of animals and plants. For example, the ivory trade has long affected the fortunes of African elephants. According to Pliny (23 to 79 A.D.), demand for ivory in the Roman Empire was so great that the elephants of North Africa succumbed. From the 16th to the early 20th century, the booming African ivory trade with Europe led to a continental decline in elephants. In the latter part of the 20th century, trade in ivory with Japan and Hong Kong precipitated yet another decline.

Overkill is thus clearly not a new phenomenon. Nor, however, is it the inevitable consequence of human utilitarianism in relation to hunting. The archaeological record indicates that certain pre-agricultural societies may have lived within the regeneration capacity of wildlife populations over long periods (18). Late Stone Age hunters seem to have adapted to their impoverished faunas after they had exterminated Pleistocene vertebrates. How they did so is seldom discussed.

Sustainable Harvesting

Three factors are associated with sustainable hunting: availability of alternative sources of food, ownership of wildlife resources, and existence of cultural and spiritual beliefs.

Alternative sources of food were available to Bushmen occupying traditional territories in the central Kalahari. When game was in short supply, the Bushmen could survive on plants. But rather than using their plant-based subsistence to exterminate local prey species, they reduced their hunting and created a sustainable lifestyle (11). Their nomadic system of utilization is thought to have lasted for at least 2000 years, without evidence of environmental degradation or species loss. Only in recent decades have wildlife populations declined. This coincided with the Bushmen being dispossessed of their land and the right to manage their natural resources.

Control of wildlife resources has also been instrumental in creating one of the success stories in African conservation. Since a change in legislation provided commercial farmers in southern Africa with effective ownership of wildlife on their lands (12), a lucrative wildlife industry has arisen based on trophy hunting, wildlife harvesting, and tourism. Wildlife populations have increased on many farms and ranches.

It has been suggested that a spiritual relationship with nature may preclude overexploitation (7). After the overkill episodes of the Pleistocene, Native Americans coexisted with the remaining prey species (though some late Holocene cultures depressed populations of large fish and mammals (19)). The environment of the precontact peoples of eastern Canada seems to have been filled with spirits that imbued animals, plants, and everyday objects with power and influence, the people apparently maintaining amicable relations with these spirits.

It has, however, been pointed out that such a close spiritual relationship with game animals, despite dictating good conduct, does not necessarily prevent overexploitation (8). Native Americans believed that by honoring a slaughtered animal in a prescribed manner they could ensure its reappearance in future hunts. In this case, should beavers disappear from a region, the intensity of trapping would not be implicated. Rather, greater care would be taken to obey the proscribed taboos. The game animals may therefore have persisted through the Holocene owing to their lack of vulnerability—just as they had survived the Pleistocene extinction.

Given our limited knowledge of the precontact relationship between Native Americans and wildlife, it is difficult to assess the relative influence of these rival expositions. But in the case of the Bushman hunter-gatherers, there is evidence of a direct association between cultural beliefs and environmental policy. Among the G/wi, it was important that respect be shown to all creatures created by N!adima (the supreme being) because each has its own place in his world, being a part of his property. Killing more than one head of game at a time would anger N!adima. Anthropologists living with isolated bands have reported that the Bushmen understood the balance between the material needs of their groups and the productivity of their semi-arid environment (11, 20).

Social Disruption

If cultural or spiritual restraints underpin sustainable living, then episodes of overkill might be expected during periods of social disruption. When infectious diseases were brought to the New World by Europeans, the Native American peoples were devastated even before most had made direct contact. It has been suggested that the ensuing epidemics undermined the shamans’ ability to influence the supernatural realm and invalidated the peoples’ sacred relationship with wildlife. This apostasy may explain the enthusiastic participation of Native Americans in a trade that locally exterminated many valuable species (7). Others have argued that the material value placed on European goods by Native Americans alone brought about the overkill of fur-bearing animals (21). In either case, some Native American groups have reestablished sustainable forms of hunting several centuries after the disruption initiated by European contact (7).

At first thought the notion of sustainable harvesting may appear to be a precarious and unlikely human enterprise, particularly in regions with expanding human populations. As previously stated, there is some suggestion in the archaeological and anthropological records that a few subsistence economies have been stable over long periods (18). Perhaps times of overexploitation punctuate rather than dominate human history.

It is generally agreed that a stable society with a secure sense of ownership of prey animals is crucial for a sustainable use of wildlife. Here, the term “ownership” refers to the sense of exclusive access or use that in modern society can be traced back to the Norman game laws in the 11th century (22). The term could also convey an intimate spiritual connection with animals and the environment. Ownership might furthermore be linked to an understanding of the habits and behavior of prey animals. Constantly knowing where one’s prey is and what it is doing may elicit proprietary feelings, whereas if the behavior of prey animals is virtually unknown—for example, because they migrate quickly through the hunter’s range—there is little incentive to care for them.

The latter type of ownership was probably absent among the bands of Paleolithic hunters moving swiftly into new hunting grounds each year, and among the Europeans of the 15th to 19th century in America, Africa, and elsewhere. All three senses of ownership would suffer in severely disrupted societies.

Conclusions

Conservationists wishing to reduce overkill are presented with two main options: make animals harder to market through restrictions on access, trade, and the use of modern technology, or provide resource users with a greater sense of ownership. The conservation community currently places much emphasis on granting exclusive rights to commercial harvesting, be it on private, state-owned, or common lands. The spiritual and knowledge-based dimensions of ownership are usually ignored. Possibly the spiritual relationship is seen as aboriginal and irrele...
vant to modern management, while the knowledge-based relationship is sidelined as academic and equally impertinent. When modern society does recognize these dimensions, it often employs them defensively: The inspiration from natural beauty is used to establish protected areas, and biological knowledge is used to set limits to the catch or bag. By contrast, the biological knowledge and spiritual understanding of the traditional hunter enhanced his sense of identity with the prey.

The role of indigenous peoples in sustaining wildlife resources is beginning to be recognized. In a few pioneering ventures, indigenous peoples have participated in the management of protected areas (23). There is room for much greater appreciation and wider incorporation of traditional beliefs, values, and knowledge in contemporary conservation and development. An ongoing exploration of these dimensions in the global context would also constructively broaden the current economic focus.

References and Notes
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Relieving DELLA Restraint
Nicholas P. Harberd

According to an old English nursery rhyme: “Oats and beans and barley grow, …, nor you nor I nor anyone knows how oats and beans and barley grow.” On page 1896 of this issue, Sasaki et al. (1) bring us closer to understanding the age-old mystery of plant growth.

The phytohormone gibberellin (GA) controls plant growth. Mutant plants deficient in GA are dwarfed, and treating these plants with GA restores normal growth (2). It is unclear exactly how plant cells detect GA, but our understanding of downstream GA signaling events is more advanced. A family of proteins, the DELLA proteins, are key intracellular repressors of GA responses (3, 4). The “relief-of-restraint” model proposes that DELLA proteins restrain plant growth, and that growth is promoted by a GA signal that relieves plants of DELLA-mediated growth restraint (2, 3).

Recent advances have put some biochemical and cellular flesh on the bones of the restraint model. For example, DELLA proteins are known to be localized in the nucleus of plant cells but disappear rapidly in response to GA (5, 6). In addition, the disappearance of the DELLA proteins induced by GA requires both protein phosphorylation and a functional 26S proteasome, the cellular organelle that degrades proteins (7).

Targeted degradation of regulatory proteins by the proteasome is an important mechanism for controlling cellular and developmental signaling in a wide variety of organisms. For example, the phytohormone auxin regulates plant development through proteasome-mediated degradation of members of the AUX/IAA family of auxin signaling proteins (8). Sasaki et al. (1) now rewrite the relief-of-restraint model in terms of specific GA-promoted targeting of DELLA proteins to the proteasome. First, they describe the properties of rice gid2 mutants. These mutants exhibit a dwarf phenotype resembling that conferred by GA deficiency. However, unlike GA-deficient rice mutants, gid2 mutants exhibit reduced GA responses and do not resume normal growth when treated with GA.

Molecular cloning revealed that the GID2 gene encodes a protein containing an F-box domain. F-box domains are found in specific SCF SCF GID2 complexes targets proteins for destruction in the proteasome by tagging them with a chain of ubiquitin molecules. GID2 may be part of an SCF complex and may interact with another SCF complex component called OsSkp2. In addition, GID2 turns out to be a rice ortholog of the SLY1 gene of Arabidopsis. SLY1 also encodes a positive regulator of GA signaling (9), which suggests that GID2 and SLY1 have similar functions.

Now that GID2 is established as a likely candidate component in a GA-specific SCF E3 ligase complex, what is the substrate of this complex? Could it be the rice DELLA protein SLR1 (6)? Sasaki et al. (1) show that in rice gid2-1 mutants SLR1 accumu-