

The Snake and the Goat, a Manager's View of Two Science, Inventory, and Monitoring Cases.

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Of the 350 some odd areas of the National Park System, very few have current inventories and consistent monitoring efforts to track a park's performance in protecting "the natural, and historic objects and the wild life . . . unimpaired . . . for the enjoyment of future generations." *The Snake and the Goat* is a tale of two such areas--one whose only inventories were of historic features; the other, of the rewards from even a modest inventory over a short time of one resource.

The Snake--War in the Pacific National Historical Park

The War in the Pacific area was studied in the 1970's as a potential Historical Park, and Congress established it in 1978. With budgets tight, and deferred responsibilities the order of the day, the new park's inventory and research concentrated on the historic ruins of the WWII period, and by necessity only of ruins associated with the U.S. reinvasion and capture of Guam.

During preliminary park studies in the mid-70's field checks of upland biotic listed the following forest birds in the proposed Historical Park:

Guam Rail	Asan, Piti, Mt. Tenjo, Agat, and Mt Alifan Units
White-browed Rail	known from forest near Park Units
White-throated Ground Dove	Asan, and Mt. Alifan Units.
Mariana Fruit Dove	Asan, Agat, and Mt. Alifan Units.
Island Swiftlet	Asan, and Mt. Alifan Units.
Micronesian Kingfisher	Asan, Agat, and Mt. Alifan Units.
Mariana Crow	Asan, Agat, and Mt. Alifan Units
Nightingale Reed Warbler	known from forest near Park Units.
Guam Flycatcher	known from forest near Park Units
Rufous Fantail	Asan, Agat, and Mt. Alifan Units
Micronesian Starling	Asan, Piti, Mt. Tenjo, Agat, and Mt. Alifan Units
Cardinal Honeyeater	Asan, Piti, Mt. Tenjo, Agat, and Mt Alifan Units.
Bridled White-eye	Asan, Agat, and Mt. Alifan Units

After park establishment there were no natural resource studies, inventories, or monitoring efforts. That isn't unusual. This is an historical area, and newly established at that. We lacked all but the barest ONPS funds. We did some resource work. We bootleg restored a small former wetland to provide habitat for the Guam Rail, a bird that seemed quite rare and in need of help.

Rare indeed! In the absence of science studies, inventory, or monitoring no one was aware that the forest avifauna had silently disappeared--entirely--from the park. Too, no one knew of a gigantic population explosion of the brown tree snake from New Guinea. The island's endemic birds which evolved in a snake free environment were totally naive of predatory tree snakes. We only now realize the alien snake completely decimated the Park's and Guam's entire native forest bird fauna. As Tom Fritts describes, the Guam bird . . .

". . . extinctions are primarily due to a single factor (Savidge 1987): the introduction of an exotic snake, the brown tree snake . . . The birds of Guam

evolved in the absence of snake predators. Since the birds of Guam had no experience with such a predator, they apparently lacked protective behaviors against the brown tree snake, and were easy prey for these efficient, nocturnal predators. Once the invasion had taken hold, the snakes spread across the island, the number of snakes began to grow exponentially, and bird populations began to decline."

Perhaps in only a decade and a half two bird species recorded from near the Park became extinct. The Guam Rail, for which we restored habitat, is extinct except for a few specimens in zoos. The Marianas Fruit Dove, Nightingale Reed Warbler, Rufous Fantail, Cardinal Honeyeater and Bridled White-eye are entirely gone from Guam and the Park. Micronesian Starlings are gone from the Park though some survive elsewhere on Guam. Guam populations of White-throated Ground Dove, Micronesian Kingfisher, and Mariana Crow are nearly extinct; they are no longer in the Park. Maybe a few Island Swiftlets occasionally come to the park as vagrants.

Of War in the Pacific National Historic Park's native forest birds only one species, the Swiftlet, may still remain. The rest, 12 species, are gone. Most are gone from Guam. Two are extinct. No United States National Park area has suffered such a massive loss of its biodiversity. It seems astounding that we failed to know it was occurring until quite long after the loss was total.

But then, perhaps it isn't astounding if we do not conduct regular, science-based inventory and monitoring programs.

The Goat--Hawaii Volcanoes National Park and Biosphere Preserve.

Feral goats were a problem at Hawaii National Park for the park's first half century. They destroyed the lowland savannah native forests and caused permanent vegetative type shifts. Mid-elevation forests were severely impacted and may have been irreparably destroyed in all but wettest sites if goat populations continued. Associated endemic plants, birds, and insects were destroyed as well. Hawaii Volcanoes has lost more endangered species than all mainland U.S. National Parks together.

The park spent enormous energies "eliminating" goats. In the half-century from 1921 to 1970 the staff eliminated the goats nearly every year. In all, a known 70,877 goats were taken from the park by a variety of means. Over the years likely a fifth of the park's annual operations and energies were devoted to doing something about goats. Still, by the early '70s there were as many goats as ever, surely more than 20,000--maybe 30,000. Biologic impacts continued unabated. By 1974 the park had lost ten species of endemic birds. Of the remainder, nine were endangered. Habitat loss by goats was certainly a contributing factor. In the early '70's goat eradication in Hawaii Volcanoes Park was as futile as snake eradication is today in Guam.

There was a difference at Hawaii Volcanoes Park, however. Volcanoes Park established its own biologist position as well as a small ranger group devoted to the feral animal problem. Their specific task was monitoring goat numbers. King Index censuses were routinely run. Remaining goat populations were regularly monitored--rather than the random "eliminate" goats efforts.

Cold biologic analyses and recurrent monitoring showed that remaining goat populations bore little relationship to the number of goats unsystematically taken from the population. Goats simply overflowed in from outside heavy populations. Too, we never took a high enough percent of the herds to affect the population. Five, or even ten thousand goats taken a year didn't equal the annual kid crop.



The Kukalauula Study Enclosure classically illustrates the newfound ungulate control understanding of the early 1970s: 1) goats did not jump 4' hogwire fences, even when malnourished and highly palatable plants visibly grew inside, and 2) rare native Hawaiian plants, safe from ungulates, flourished inside the fence. Outside the fence all were alien plants, browsed to the rootstalks.

Another blue-chip revelation came from an early goat enclosure built to evaluate what might grow if goats weren't present. No one had much hope for the small experiment because goats would just jump the enclosure fence--but the biologist and resource rangers persisted. Figure 1 is an early enclosure at Kukalauula Pali. It is astounding. Most fanfare greeted the undescribed endemic bean species that appeared as a "phoenix" from a century earlier. But the more remarkable discovery of the enclosure and picture is that **no goats jumped the fence**. "Ice cream" plants grow inside the fence. But goats don't jump over fences. We didn't know that.

So, if it was possible to keep goats from a half acre of delicious browse, why not from 5,000 acres? A unit 5,000 acres in size might allow the staff to remove such a high percentage of the herds that the **population would actually be reduced for the first time**. This was done--not easily. The last few goats required two ranger-years of hunting. The survivors of such persistent hunting are incredibly canny. These extraordinary few goats are smarter than the average ranger. Maybe it didn't seem worth devoting two ranger-years to killing three goats, **but science reminded us that with three goats we would remove the entire population!** That's worth the effort.

Monitoring by dedicated biologist and wildlife trained rangers had demonstrated that a park could be freed of goats if the public wanted to pay the cost--fencing 200,000 acres with a honey-comb of many 5000-acre goat enclosures. The park began to do just that, but with ever larger units as goat hunting techniques and fencing ability improved. Monitoring continued. King Index censuses were kept up until vegetation responses and declining goat populations negated the King Index as a technique. Once, in an effort to find *some* sort of indices to monitor low goat numbers, resource crews radio-collared a few goats to monitor check census techniques. They stumbled into another revelation. Goats were herd animals. The newly radioed goats quickly joined others. That is, **they found and joined existing bands** of goats. Ah ha! No longer were such small enclosures needed to remove all goats from a unit. Merely park boundary fences and a few large unit fences were required with the newly discovered radio-collared "Judas goats" to lead resource rangers to small pockets of wily goats. This also became a cheap, continuing monitoring system--a few "Judas goats" on the park payroll.

Today all goats are gone from the vast areas of Hawaii Volcanoes Park with fenced management and "Judas goats." Nearly all are gone from Haleakala National Park (using only two fenced goat units). Before the discovery of the fenced units and Judas goats no one had ever tried goat control at Haleakala. Everyone knew "it was utterly impossible in that terrain."

And it was utterly impossible without routine and skilled biologic studies of the unsolvable disaster, and regular biologic monitoring of the park's condition.

The Point of a Monitoring Program

Not surprisingly the savings realized simply by discovering that fences could keep out goats; the population dynamics predictions of how large an area from which goats could be removed; and inventing the Judas goat technique more than equaled the cost of the biologist and goat resource program that led to this form of management. If you visit Hawaii Volcanoes or Haleakala, you'll still find Hawaiian honeycreepers, koa and ohia native forests, even thousands of silverswords. That's infinitely more important than that the science and monitoring saved us more money than it had cost.

Pity we didn't do that with the snake. But then, without routine biologic monitoring, who would ever know the snake was there?

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