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the Revival of Peru’s Guano Industry,
1909-1965

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"the most valuable birds in the world": international conservation SCIENCE AND THE REVIVAL OF PERU'S GUANO INDUSTRY, 1909–1965

GREGORY T. CUSHMAN

EXCREMENT IS NOT considered a topic of polite conversation, yet it is a fundamental and 1
unavoidable part of biological existence. Such attitudes have ancient roots in taboos
governing religious purity. The Mosaic law commanded: "Designate a place outside the camp
where you can go to relieve yourself. As part of your equipment have something to dig with,
and when you relieve yourself, dig a hole and cover up your excrement. For the LORD your
God moves about in your camp to protect you and to deliver your enemies to you. Your camp
must be holy, so that he will not see among you anything indecent and turn away from you."
But in our secular age, these attitudes are more a reflection of how divorced urban, industrial
existence has become from natural cycles and humanity's agrarian roots. Thus, the
ecologically enlightened in our disposable society now have to read special books about "how
to shit in the woods" to protect the wilderness from harm. There is even a book to teach
children that "everyone poops."¹

This separation is due, in large part, to the great success experts have had at manipulating 2
natural processes for the rest of us. A major task experts have been asked to perform over
time has been to hide, wash away, and otherwise protect us from the scourge of our own
excreta. As a consequence, the fundamental significance of *merde en l'histoire* has been
largely hidden, with one major exception: The extraction of guano, the accumulated
droppings of marine birds, is a dominant theme in Peruvian history. In fact, the period 1840–
1880 is known as Peru's "Guano Age."²

During the first decades of the nineteenth century, European scientific travelers 3
appropriated Andean knowledge of vast natural sources of nitrogen along the Peruvian coast
for use by farmers in the Northern Hemisphere. From 1840–1880, Peru exported an estimated
12.7 million tons of guano from its islands with a sale value in the range of £150 million (\$13
billion in today's dollars, see [Fig. 1](#)).³ This bonanza inspired a global rush to colonize even
the remotest specks of land in order to exploit any bird colonies—or *kanaka* laborers—who
might help produce this valuable fertilizer. Peru's ruling elite tried to use this geographical
advantage to engineer a modern nation, but their project ended in tragedy, as one of the
world's great mining booms turned bust. In 1879, after exhausting Peru's major guano
deposits, the nation's leaders went to war with Chile over a second coastal resource, immense

deposits of inorganic sodium nitrate in the Atacama Desert. This devastating war over the wealth of nature—one of the largest armed conflicts in the history of the Americas—practically demolished the "fictitious prosperity" created during Peru's Guano Age.⁴

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Figure 1. Guano Production in Peru, 1840–1975.

Chart by author.

Yet Peru's rulers refused to give up on the belief that Peru's rich marine environment would enable them to realize their dreams of national development. Like so many of their peers around the world, Peru's rulers looked to scientists for help. They joined a global movement at the turn of the twentieth century that empowered conservation technocrats to manage the natural world in accord with "the gospel of efficiency." As this study will show, this technocratic trend was just as prevalent in some postcolonial states struggling for autonomy in the global South as it was in the industrial powers of the North and their colonial dependencies. In fact, events in Peru laid the groundwork for U.S. scientists to extend their influence to other parts of the postcolonial world, often employing environmental ideas and techniques developed elsewhere in the tropics. These scientists not only focused on forests, rivers, plantation crops, and big game, they also valued humble creatures—even the excrement they produced—as long as they served some productive purpose for humankind.⁵

Scientific conservation achieved one of its greatest triumphs shepherding three wild bird species native to the Peruvian coast. Historians of science and technology in the "developing world" have long cautioned us to use different criteria for success than those common in the industrial world.⁶ By these and other measures, the revival of Peru's guano industry was wildly successful.

First and foremost, it was an economic success. Unlike the Guano Age, which depended on boom-bust exploitation of centuries-old deposits that were exported to feed crops half a world away, this new era relied on a sustained yield of excrement from Peru's existing marine

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bird population in order to supply domestic agriculture. Beginning in 1909, environmental experts implemented a program that led to dramatic increases in the guano bird population and the production of excrement for human benefit. Indigenous workers dug up 7.6 million metric tons of fresh guano to serve Peruvian agriculture under this new system before its final collapse during the El Niño event of 1965. Extraction and sale produced a net profit to the Peruvian state and private shareholders worth over \$650 million in today's dollars, in addition to increases in local agricultural productivity.⁷ These profits directly funded further scientific research in Peru. Compared to the fleeting gains produced by so many development projects, the Peruvian guano industry accomplished almost exactly what its managers envisioned over a period lasting five decades.

Second, this economic success helped foster new mind-sets toward the natural world, both in Peru and abroad. It forged a consensus among Peru's ruling elite that the guano birds were valuable as a *living* resource that could be managed much like farm animals. It is therefore no coincidence that many Peruvian agronomists—and not a few agribusinessmen—embraced scientific conservation and attempted to extend its lessons to other realms. A few of them became outspoken defenders of the guano birds and other wild creatures. But the guano birds turned out to be quite different from domesticated animals: Not only were they frustratingly mobile, but their population oscillated wildly, especially during El Niño years. In fact, the human beings who dug up guano and applied it to their fields proved much less frustrating to manage using scientific techniques. These realities led scientists to become intensely aware of the complexity of Peru's marine environment and of the potential ecological significance of "all things rude and nasty, ... all creatures short and squat." The ability of scientists to rapidly convert these insights into better ways to manage the guano birds testifies to the success of their approach to Peru's marine environment.⁸

Finally, the long-term success of this conservation project gave birth to one of nature's great spectacles: By the mid-1950s, up to 40 million adult birds patrolled Peru's coastal waters. For good reason, mid-century U.S. conservationists hailed this experiment as "the greatest of all industries based upon the conservation of wild animals" and sought to extend this system to Chile, Mexico, and beyond.⁹ The variability of Peru's marine ecosystem, meanwhile, inspired conservationist William Vogt to reevaluate his attitude toward death and decay and to target human population growth as the greatest threat facing modern civilization, a view that became orthodoxy for the modern environmental movement.¹⁰ Historians must look to such success stories in order to understand how experts acquired enormous influence worldwide over environmental governance in the course of the twentieth century, as well as to evaluate the limitations to expertise, especially when it is associated with authoritarian rule.¹¹

SOLVING "A NATIONAL PROBLEM"

IN THE AFTERMATH of the War of the Pacific (1879–1883), a few Peruvians began looking for ways to make guano a part of postwar economic reconstruction. In 1890, the Peruvian government ratified the so-called Grace Contract. This agreement discharged Peru's huge foreign debt and restored its ability to negotiate international loans. In return, the Peruvian Corporation of London received control of Peru's railways for sixty-six years. The Peruvian Corporation promised to extend and modernize these lines in return for 2 million tons of guano, while the Peruvian government reserved the right to extract guano from the

Chincha Islands for Peruvian agriculture (See [Map 1](#)).¹²



Map 1. The Guano-Bearing Regions of the Peruvian Coast.

Map by author.

After more than a decade of almost constant civil war, Peru regained a measure of political stability when the charismatic strongman Nicolás de Piérola grabbed the reins of power in 1895. He agreed to share influence over Peru's central government with the old oligarchy that retained power along the coast from the prosperous days of the guano boom. This loose confederation of elites gained further support by recognizing the regional power of the landed aristocracy of the Andean highlands, or Sierra. These interest groups joined together in part because they shared a desire to put Peru back on the path to prosperity. Power

sharing allowed Peru to enjoy a relatively peaceful period from 1895 to 1919, which historians term the "Aristocratic Republic."¹³

Political peace allowed economic expansion to return to Peru. Mine owners and wool producers enjoyed greater access to markets linked to the expanded railroad system in the Sierra. Plantation sugar production along the coast grew rapidly thanks to favorable international prices, and even the remote Amazon region prospered briefly during the rubber export boom. This expansion also derived from the development of local industry; the beginnings of copper, cotton, and petroleum exports; and the influx of U.S. investment. These development patterns led to the wholesale transformation of local ecosystems, as they were integrated with the world economy. Agricultural development also meant that the Chinchas became inadequate to supply the growing fertilizer demand from coastal fields of export crops.¹⁴ 11

The return of prosperity nurtured a progressive, nationalist ethos among Peru's coastal elite. The rulers of country after country around the world during this era looked to "scientific politics" as the answer to the ubiquitous problem of "order and progress." Self-proclaimed positivists promoted the scientific study of natural resources and hoped to use these studies to craft plans for their rational development. To this end, the Peruvian state organized a Ministry of Development and several other scientific institutions.¹⁵ 12

Peru's incredibly rich coastal waters were an obvious target for scientific development. Large-scale geophysical forces cause prevailing southeast trade winds to blow along the Peruvian coast. These forces push the surface waters of the Pacific Ocean toward the northwest to be replaced by cool, subsurface water. As in all upwelling ecosystems, enormous populations of phytoplankton flourish on dissolved nutrients surfacing from below. In the words of Robert Cushman Murphy these microscopic organisms provisioned "vast, seething schools of surface fish, breaching whales, incredible flocks of birds ... bands of frolicking lobos ... [and] enormous shoals of porpoises," making coastal Peru one of the most productive marine environments in the world. On the adjacent land, in contrast, these conditions create one of the most arid, least productive natural environments in the world. This dryness inhibits both the microbiological breakdown of uric acid ($C_5H_4N_3O_3$) and the leaching of water-soluble ammonia (NH_3) and ammonium salts (NH_4^+) from guano deposits and makes them uniquely rich in nitrogen. Unfortunately for most of the creatures that depend on these climatic conditions, the Peruvian littoral is periodically disturbed when the trade winds fail, thus allowing the influx of warm, nutrient-poor waters from the north. A local term for this phenomenon is now used by scientists to denote one of the world's most important climate mechanisms: the El Niño-Southern Oscillation.¹⁶ 13

In 1906, following a long-established pattern of consulting foreign experts for developmental advice, the Peruvian Ministry of Development hired fishery biologist Robert Coker to study its marine resources and formulate "scientific principles" to serve as "a guide to the conservation and reproduction of species" in Peruvian territorial waters. Reliance on external advisers has been one of the hallmarks of technocratic management of natural resources, not just in Latin America but throughout the colonial and postcolonial world. Indeed, outside experts played a controversial role in evaluating the extent of Peru's guano deposits during the nineteenth century.¹⁷ The son of a prominent South Carolina cotton planter, Coker had recently completed a PhD in zoology at Johns Hopkins and a series of government reports establishing new policies for oyster conservation along the Carolina 14

coast. Peru wanted Coker primarily to help revive its depleted marine shellfish industry, but he accomplished much more. In his report on the guano birds, Coker identified three species that produced usable quantities of excrement: the *guanay* (*Phalacrocorax bougainvillei*, a small cormorant or shag), the *piquero* (*Sula variegata*, a booby), and the Peruvian pelican (*Pelecanus thagus*, a close relative of the North American brown pelican), all members of the order Pelicaniformes (See [Fig. 2](#)).¹⁸ Coker countered the widespread notion that Peru's guano deposits were close to disappearing forever. He thought the remaining birds could easily produce enough excrement to fulfill the needs of both Peruvian agriculture and the Grace Contract if Peruvians stopped acting "like beasts of prey" toward the guano birds and began treating them as "domestic animals."¹⁹



Figure 2. Symbols of Peru's Guano Age, Old and New.

Courtesy PROABONOS, Peru.

A shipwrecked guano vessel alongside a vibrant colony of piqueros (*Sula variegata*).

As with Carolina oysters, Coker thought rational management of the guano birds required state intervention. He recommended a five-part policy designed to produce a sustained yield of guano each year: 1) Peru should immediately turn all coastal islands into a bird sanctuary under state supervision and permanently prohibit any private use of island resources, such as egg collecting and hunting. 2) Only one state contractor per island should receive the concession for guano extraction, in the hope of relieving the disruption of breeding caused by intense competition for deposits. 3) Peru should establish a permanent closed season during the November to March breeding period to allow the birds to reproduce in peace. 4) But since the entire year was important to the cycle of breeding, Peru should implement a rotation policy. Each island should be closed for at least one year between each season of guano production—the longer the closed period, the more the birds could reproduce. Peru already had implemented a rotation policy on the three Chincha islands to protect the guano birds, but Coker recommended applying this policy systematically to all the guano-producing areas in Peru. 5) Ideally, Peru should create a national monopoly responsible for the entire process of guano production and distribution. Coker strongly believed that a single, state-run company with a long-term stake in the bird's welfare would best provide for Peru's common interest. Since the Peruvian state already owned the guano islands, it possessed most of the legal power it needed to make these changes. In classic technocratic fashion, Coker quantified the wealth he thought Peru would accrue from his scientific plan: He "conservatively appraised" the guano produced by each pair of birds at \$15 per year.²⁰ 15

As in the United States, conservationists found many converts to the gospel of efficiency among Peru's capitalist class. Though a foreign scientist prepared the ground for the revival of the Peruvian guano industry, prominent Peruvians actually planted the seed. In March 1909, Cuban-born financier José Payán de Reyna (president of the Lima stock exchange) and President Augusto Leguía (former manager of the British Sugar Company and outspoken admirer of the United States) masterminded the formation of the *Compañía Administradora del Guano* (CAG). This parastatal company received the sole right to extract, transport, unload, and sell guano to Peruvian farmers. CAG was strictly required to protect the guano birds in "whatever relates to the reproduction of fertilizer." An executive decree gave CAG direct control over all bird colonies south of Callao except for a region stretching from the Ballestas Islands to Punta Doña María.²¹ 16

CAG faced a crisis of public confidence almost as soon as it began producing guano. Guano sales to Peruvian farmers fell precipitously during CAG's first three years of operation as CAG rotated harvests on the Chincha Islands, the most productive area under its jurisdiction. To make matters worse, "sinister ocean currents" arrived from the north in 1911 and caused the guano birds to flee their breeding colonies en masse; this El Niño event ruined the season's production of fresh guano and caused the deaths of tens of thousands of nestlings and eggs. Meanwhile, the Peruvian Corporation of London continued to export two-thirds of Peru's total output during these years. Local farmers hoarded whatever they could of the limited supply. This situation eventually spurred the Peruvian government to close the Ballestas Islands, the Peruvian Corporations's most productive territory, in March 1914 in order to allow the bird population and guano levels to regenerate. The islands were to reopen in 1916, but only to provide fertilizer for Peruvian agriculture.²² 17

The Peruvian government justified this aggressive action by invoking the twenty-first clause of the Grace Contract, which allowed "the government of Peru to consume the guano that is necessary for its agriculture" and which gave the Peruvian Corporation the sole right to export "existing guano." British stockholders immediately protested and warned that this unilateral action would threaten Peru's ability to negotiate foreign loans, but the Peruvian executive and Congress stood firmly by the decree. A consortium of farming and industrial interests chimed in with a statement that reveals the mentality behind CAG's creation. "The rational fertilizing of the earth," they asserted, acted as the key to agricultural growth, since it "put into circulation ... materials that exist in a latent state in nature." This practice enabled the "necessary progressive evolution" of Peruvian agriculture "from an extensive to an intensive system." With its unique capacity to produce guano, Peru could make up for its "inferior economic conditions" and quickly catch up with rich agricultural nations. Input-intensive agriculture also would solve dire social problems: it would accomplish "progressive enculturation" of Peru's rural poor and lower food prices for the coastal "proletarian masses." In other words, Peru had an enormous stake in this controversy because guano had the potential to carry the nation forward into the modern world.²³ 18

A foreign expert added fuel to this controversy. In fact, the Peruvian Corporation's European managers had long known that they depended on Peru's living guano birds for their share of the guano harvest. The Peruvian Corporation hand-picked its own expert to study declining production and discover means to encourage its "conservation and increase"—Scottish naturalist Henry O. Forbes, a distinguished scientific explorer of Oceania and bird enthusiast who recently had retired as director of the Museums of Liverpool. Although he did not recognize the connection, Forbes may have been the first naturalist to study the ecological impact of the El Niño-Southern Oscillation on both sides of the Pacific. He witnessed the ravages of the great drought of 1877–1878 on the forests and plantations of Indonesia, and he arrived in Peru on Christmas Day, 1911, just in time to witness the advent of El Niño. After receiving President Leguía's blessing, Forbes spent more than a year studying Peru's guano birds in the field.²⁴ 19

In a February 1913 report, Forbes outlined major threats to the guano industry. He acknowledged the danger posed by El Niño and the guano birds' natural enemies, but he focused far more on the ways human behavior jeopardized the guano birds' well-being. First, he noted that ill-timed extraction often interfered with mating and nesting. He particularly condemned exploitation on the Ballestas Islands, where for the past ten years the Peruvian Corporation consistently had begun harvest in April, before the chicks could fly. Forbes admonished, "This is without a doubt one of the principal causes of the decline of the birds." Second, he pointed out the threat posed by coastal fishermen and guano workers who illegally stole eggs and chicks, although he discounted the damage caused by illegal dynamite use and other fishing techniques that potentially affected the birds' food supply. Third, he criticized the hiring of independent contractors to harvest guano on the islands because they sought to maximize short-term profits with little regard for the birds' welfare.²⁵ 20

Forbes concluded with a series of recommendations. Anyone who expected this product of British imperial science to automatically decide in favor of his employers was sorely mistaken. Forbes took a radical stand on the meaning of clause twenty-one of the Grace Contract: The Peruvian Corporation only had the right to mine deposits that existed in 1890; in his view, the Peruvian Corporation had since stolen thousands of tons of fresh guano that rightfully belonged to the Peruvian nation. Therefore, he declared that all guano islands 21

except for Lobos de Afuera should be put under CAG's conservation-minded administration; the Peruvian Corporation could mine the old, rain-leached, nitrogen-poor guano deposits on this island to fulfill its remaining quota. Following Coker's lead, Forbes suggested additional policies to improve the birds' welfare: 1) private contractors should be banned from harvesting guano; 2) yearly extraction should take place only during the winter between breeding seasons; 3) the period between harvests on each island should be increased to three or four years; 4) no unauthorized visitor should come within one mile of the islands at any time; 5) the guano birds' natural predators should be systematically shot or poisoned; 6) an armed guardian force with gasoline-powered boats should patrol the coastal waters to keep the islands in "a state of perfect rest." Furthermore, Forbes advised Peru to set up coastal research stations to record oceanographic data and to hire scientists to regularly inspect the islands.²⁶

Despite pressure from nationalists in the Peruvian Congress to escalate the confrontation, CAG made a deal. CAG promised to purchase fertilizer directly from the Peruvian Corporation in order to provide fertilizer to all Peruvian farmers who requested it. To prevent hoarding, CAG agronomists acquired the power to closely supervise Peruvian agricultural practices. These actions enabled CAG in 1915–1916 to meet national fertilizer demand for the first time without rationing.²⁷ 22

Far-away events ultimately resolved this controversy. World War I created an enormous market for sodium nitrate from the Atacama Desert to keep Europe's guns blazing. High freight costs from South America and the post-war depression prevented the Peruvian Corporation from exporting guano from mid-1916 until mid-1920. The corporation's absence freed CAG to take over management of the entire coast. Fritz Haber and Carl Bosch, meanwhile, developed an industrial technique to synthesize nitrogen compounds. Their discovery enabled Germany to keep fighting. The Allies learned the secrets of this catalytic process as one of the spoils of war. Powered by cheap fossil fuels, chemical giants DuPont and BASF soon built enormous fortunes producing nitrogen fertilizer (and eventually nylon) using the Haber-Bosch process. By the time of the Great Crash, this technological revolution had eliminated the northern market for both guano and nitrates, even as it accelerated the worldwide shift toward input-intensive agricultural practices that began during the Guano Age. On 12 November 1929, with the world hurtling toward the worst economic depression in modern history, the Peruvian Corporation gave up its remaining interest in the Peruvian guano industry, even though it was still owed 624,000 long tons under the terms of the Grace Contract.²⁸ The leaders of Peru's Aristocratic Republic thus used foreign expertise to their advantage in order to establish national autonomy in fertilizer production (albeit to export crops for consumption in Europe and North America). This qualified as a major success for this oft-maligned "neocolonial" era of Peru's history—a success comparable to the great hydraulic and forestry projects built by the *científicos* and positivists in charge of Porfirian Mexico and Brazil's Old Republic.²⁹ 23

MANAGING AN AGROECOLOGICAL SYSTEM

DURING THE TWENTY-FIVE years following Forbes's 1913 report, CAG technocrats gradually consolidated their control over a complex agroecological system linking the enormous productivity of Peru's marine environment to the export of staple crops from the adjacent coast.³⁰ They used the latest scientific understanding, not only to manipulate the 24

wide variety of organisms affecting the welfare of birds, but also to manage the behavior of human beings who extracted and used guano. Conservationism, hygienism, and Taylorism worked in tandem to maximize the production of excrement for Peru during an era when scientific management took the world by storm—on both sides of the North-South, East-West, urban-rural, and human-animal divides. Ecology was a science of industrialization.³¹

The most significant action taken by CAG during its early years involved protecting the birds from the guano industry itself. Scientific traveler Robert Cushman Murphy described "thick beds of bones in hollows and gulches" on the guano islands, which evinced the industry's destructive potential. According to locals, thousands of young birds "were driven to slaughter by wanton guano contractors in the old time purely [to get] them out of the way of the diggers." Following Forbes's recommendation, CAG stopped contracting out the guano harvest in 1914. This gave CAG much more control over the behavior of its workers, and they were strictly ordered to leave the birds alone. CAG consistently set harvest times to come after the end of peak nesting season on each island. With these policies in place, the guanay and piquero became acclimated to the presence of workers, while the breeding pelicans on Lobos de Afuera and Lobos de Tierra flourished during the Peruvian Corporation's wartime absence. Later scientific studies showed that CAG's extraction practices caused, at worst, an ephemeral, local decrease in the guano bird population.³² 25

In contrast, the rotation policy promoted by Coker and Forbes was not nearly as important to reproductive success as these scientists predicted. CAG rotated harvests on most islands and points, but it did this quite haphazardly. It made almost no attempt to alternate harvests on two of its most productive guano islands, Isla Guañape (dominated by piqueros) and Isla Macabí (dominated by guanays). That laxness had no obvious ill effects. CAG's managers instead chose to follow the expert recommendations of agricultural chemists whose studies showed that guano on these relatively damp, northern islands lost significant potency after a year or two. Nevertheless, CAG consistently credited its "scientific" rotation policy for production increases, even when the practice was criticized.³³ 26

Both Coker and Forbes agreed that island trespassers posed another significant threat to the guano birds. The presence of a malevolent human collecting guano, eggs, or chicks could spook an entire colony. Consequently, CAG established permanent guard stations (usually manned by a single guard) on nine islands and three coastal areas in 1915–1916 to protect the largest colonies. It gradually extended this network to encompass the entire coast, as company finances permitted. Their presence practically eliminated the trespassing problem. But CAG's guardian system had a decidedly negative impact on other coastal bird species. Island guards routinely hunted three birds to provide fresh meat for their sparsely provisioned tables: the *potoyunco* or Peruvian diving petrel (*Pelecanoides garnotii*), the *chuita* or red-footed shag (*Phalacrocorax gaimardi*), and the *pingüino* or Humboldt penguin (*Spheniscus humboldti*). Repeated guano extraction also disturbed the breeding of the *potoyunco* and Humboldt penguin by removing the material they need to dig nesting burrows. These birds, common during the mid-nineteenth century, were virtually eliminated from the guano islands. Today, despite recent legal protections, the *chuita* is classified as "near threatened" and the Humboldt penguin as "vulnerable." The *potoyunco* only breeds in four locations and is in imminent danger of extinction. These marine birds were unintended victims of the guano industry's success.³⁴ 27

CAG intentionally tried to rid the guano birds' natural enemies from Peru's coastal 28

islands. The *simeón* or band-tailed gull (*Larus belcheri*), the cleo or kelp gull (*L. dominicanus*), the *pájaro ladrón* or southern skua (*Catharacta skua*), the *gallinazo* or turkey vulture (*Cathartes aura*), and the *buitre* or Andean condor (*Vultur gryphus*) all preyed on the eggs and chicks of the guano birds. The *gavilán* or peregrine falcon (*Falco peregrinus*), in contrast, caught adult guano birds on the wing. In 1915, in line with Forbes's recommendation, CAG began systematic extermination of these predatory birds as a part of its comprehensive conservation policy. In 1918, CAG armed its entire force of island guardians and lighthouse keepers to shoot predatory birds on sight. Robert Cushman Murphy reported that marksmen killed more than five thousand gulls in February and March 1917 on the southern islands, although the birds were "extremely abundant" again when he visited a couple of years later. Murphy at first thought it "seemed criminal that sharpshooters ... should be employed for the express purpose of killing such magnificent creatures as condors. But after witnessing the damage that these birds had done at Asia" Island, where eighteen condors systematically eliminated the island's entire breeding colony in a matter of days, his "sympathies inclined more toward the victims and the practical attitude of the guano administration." Since CAG raised "defenseless" guano birds in "a system of more or less artificial culture," Murphy's moral calculus allowed these "veritable harpys" to be executed with little remorse (see [Fig. 3](#)).³⁵



Figure 3. Casualties of the War Against Varmints.

From Robert Cushman Murphy, *Bird Islands of Peru* (1925).

Andean condors (*Vultur gryphus*) killed by CAG sharpshooter Melitón Lurquín.

From 1937 to 1939, CAG purchased 47,500 shotgun cartridges to kill predatory birds, an indication of the scale of this organized slaughter. But this was not wanton killing: Abundant evidence shows that these campaigns against "varmints" (especially condors) were vital to the establishment of new colonies and the rapid expansion of the guano bird population. Luckily, these campaigns were never extensive enough to extirpate predatory birds from the coast.³⁶ 29

The same cannot be said for a more vulnerable member of the marine community. *Lobos del mar* or sea lions (*Otaria flavescens*) occupied an ambiguous place in CAG's official predator policy. Many local fishermen believed that "a working understanding" operated between the lobo and the guanay: Sea lions attacked from below and herded the fish to the surface where birds (and fishermen) could pick them off at will. Based on this belief, Peru banned sea lion hunting in 1896. Then Robert Coker published a study on the subject. As a good conservation scientist indoctrinated to the gospel of efficiency, Coker valued the lobos in terms of their impact on the guano birds and other marine industries. He concluded that lobos were neither beneficial nor harmful toward the guano birds; therefore, from the guano industry's point of view, they could be hunted for their skins, oil, meat, and whiskers. President Leguía followed Coker's suggestion and reopened lobos hunting in 1910. CAG obtained a five-year monopoly concession to hunt lobos in 1919 and again in 1936, based on the argument that independent sea lion hunters posed a threat to the guano birds. CAG killed as many as 36,500 lobos (mostly pups) in a single season, both to supply the local fur trade and increase the company's profitability, and to guard against the off chance that they might someday kill a guano bird. Coker provided no compelling reason to preserve large sea lion populations, which a new generation of market fishermen came to view as pests. So the Peruvian state made little attempt to rein in the killing, despite the caution of later scientists, until the lobos population bottomed out at eight thousand in 1961. A single conservationist's utilitarian stance thus nearly led to a regional extinction.³⁷ 30

CAG looked to a different set of experts to orchestrate its campaign against the guano birds' microscopic parasites. Bio-medicine was the most advanced sector of Peru's scientific establishment during the early twentieth century, as it was in many parts of Latin America. This was due in part to the far-reaching triumph of tropical medicine, but also to growing interest in tropical plant pathology, livestock diseases, and a vigorous local tradition of environmental medicine known as "Andean biology."³⁸ After Forbes's report, CAG workers began systematically dumping tons of island stones into the ocean to "clean" the islands for the birds. With this policy, CAG hoped to rid the islands of blood-sucking ticks (*Ornithodoros tulaje* and *O. amblus*) which lived under surface rocks, infested the birds and guano workers, and potentially carried blood parasites. CAG became obsessed with pathogens in the wake of the 1917 El Niño. In one of the first major scientific papers on the ecological impact of El Niño, Peruvian agronomic engineer José Antonio de Lavalley y García concluded that the common fungus *Aspergillus fumigatus* had caused massive bird mortality on the guano islands during the changed, "tropical" climate of this event. He believed disease threatened the well-being of the entire guano industry, so he recommended burning all bird corpses, culling all sick birds, and spraying the islands with sanitizing disinfectant or hot water after each harvest. In 1924, famed Peruvian bacteriologist Julio César Gastiaturú Rocco made a major discovery. He isolated the first wild instance of deadly avian cholera (*Pasteurella* 31

multocida), a bacteria typically spread by fecal contact. CAG eventually banned domestic fowl from the islands to prevent the introduction of new avian diseases.³⁹

The principles of conservation, efficiency, and hygiene also influenced CAG's managerial stance toward guano workers and their ecology. Guano production still depended upon back-breaking labor with simple hand tools: pickax, shovel, screen, jute sack, and brooms to pick up the last speck of valuable dust. The guano industry no longer imported coolie workers from East Asia, as it had in the nineteenth century. Instead, CAG recruited seasonal wage laborers from the Sierra.⁴⁰

Working conditions on the guano islands were difficult if not downright dangerous, although they were a marked improvement over the dark days of the Guano Age. Most guano workers contracted conjunctivitis, chronic coughs, and other respiratory problems from exposure to pulverized guano. Bronchitis, malaria (the scourge of highland migrants to the coast), and influenza were the most common causes of worker hospitalization. Their disease ecology also overlapped with the guano birds: Ticks, especially in their larval stage, easily adapted to feasting on human hosts. As on coastal plantations, CAG provided a spartan diet of easily transportable foods: rice, beans, dried meat, hard bread, and tea with sugar. During CAG's early years, workers occasionally suffered from scurvy from lack of fresh food. Guano workers had to provide their own bedding and usually slept in crude tents made from wood frames, woven cane, and old sacks that typically harbored clouds of flies bred by poor sanitation standards. Hygienists and labor activists routinely complained about this work environment. In response, beginning in 1916, CAG paid a series of physicians to study health conditions on the islands, recommend improvements, and provide free medical care to its workers. Their intervention led to the gradual construction of new hospitals and "scientifically prepared, hygienic habitations" on the islands. In later years, in line with populist tendencies in Peruvian politics, CAG offered life insurance and off-season housing to its workers and sports facilities on the islands. The fact that CAG was publicly owned made it far more receptive to pressure to improve working conditions than privately owned businesses in the region.⁴¹

But all of this came at a cost for workers. CAG scrutinized the workers with disciplinary zeal. Even worker defecation and sexual practices came under surveillance. Physicians not only sought to avoid polluting the guano islands with human excrement, they also sought to prevent fights, sodomy, and other so-called pathological behaviors on these remote island outposts. During the early 1940s, when CAG began paying its workers by the task in an attempt to increase worker efficiency in response to a fiscal crisis caused by El Niño, it hired a new class of overseers (*tarjadores*) to carefully record every kilo of guano produced and every gram of food eaten. CAG relied on scientific management to discipline its workers into increasing guano production, rather than resorting to violence, as it had against the guano birds' natural enemies. Remarkably, the guano islands were mostly free of labor unrest over the years.⁴²

From this ecological base on the guano islands, CAG gradually built an integrated industry with monopoly control over almost all levels of fertilizer production, transport, and sale in Peru. Burros, small railway cars, and trolleys were the only labor-saving devices in use in 1909, but CAG gradually built an extensive island infrastructure with docks, roads for motorized tractors, barracks, administration buildings, guard houses, and even lighthouses to aid coastal navigation. CAG started without any boats to carry guano to port. It purchased its

first steamer in 1912 and by 1926 controlled a large, diverse fleet of steamers, pontoon boats, and sailing ships. CAG gradually developed a network of warehouses and shops to distribute guano, including several offices in the Sierra that provided agricultural extension services. But CAG's most important innovation involved price-setting. A CAG official removed a scoop of guano from every sack that arrived at a mainland port, mixed it in a bag with samples from all other sacks in the same shipment, and sent the combined sample to Lima for chemical assay. Purchasers promised to pay a standard price set by the Peruvian central government based on the average nitrogen content of the lot. Faith in chemical science guaranteed the hidden content of this product and the value of the exchange. This "objective" system replaced the face-to-face negotiation once used to set agricultural prices with an impersonal standard set by technocrats far away.⁴³

CAG's duties went beyond fertilizer extraction and delivery. Its mission to promote scientific modernization focused on CAG's customers—Peruvian farmers. An agronomist trained at Peru's new National Agricultural School, José Antonio de Lavalley y García, took the lead in these endeavors. Like so many sons of the ruling families of Peru's Aristocratic Republic, Lavalley chose a technical career. In 1914, after making a name for himself touring the Peruvian coast studying fertilizer use and defending CAG from its critics, he took charge of CAG's Technical Section. Besides fertilizer assays, labs under his supervision performed free soil, water, and pesticide analyses for farmers interested in using the latest scientific techniques to manage their crops. In 1926, CAG organized its own agricultural research station under his command. Farmers also received propaganda and scientific studies from CAG that promoted scientific agriculture, including a monthly illustrated *Boletín* (1925–1967). These publications provided a vital public outlet for scientific research in Peru for more than four decades. They constantly reminded farmers that their soil's fertility was derived from nearby marine birds, in stark contrast to the abstraction of commodities from their original ecological context so often characteristic of modern agriculture.⁴⁴

Core members of Peru's dominant class, agro-exporters, reaped enormous benefits from this agroecological system, which redirected the enormous productivity of Peru's marine environment to the adjacent coast. Peruvian law kept guano prices low while paying substantial dividends to the Peruvian state and CAG's private investors (most of whom were agribusinessmen). Twenty-five large purchasers consumed half of CAG's total production from 1909–1935, even though they represented a miniscule fraction of the farming entities that purchased guano. Cultivators of less than one hectare received only one-tenth of CAG's total production during this period; the other 90 percent went almost exclusively to vast monocultures of two export crops, sugar cane and cotton (see [Fig. 4](#)).⁴⁵ These guano distribution practices clearly reflected Peruvian social realities: the concentration of irrigated coastal landholdings in the hands of a few, the lasting political power of coastal agroexporters, and their continuing dependence on consumers in the Northern Hemisphere. Meanwhile, the majority of coastal Peruvians, even those who worked the land, came to rely on expensive imported foodstuffs for survival. A series of crises eventually forced CAG to address the notorious "land problem" along the Peruvian coast.⁴⁶ That CAG was able to adapt so well to these circumstances represents yet another success.

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Figure 4. An Industrial Island in a Monocultural Sea.

From George R. Johnson, *Peru from the Air* (1930).
W. R. Grace & Co.'s Paramonga sugar estate near Supe. This plantation purchased 48,413 tons of guano from 1909–1935, making it CAG's third-largest customer.

DEALING WITH "ECOLOGICAL DEPRESSION"

THE AGROECOSYSTEM MANAGED by CAG was not stable. Far from it. CAG's managers confronted significant El Niño events in 1911–1912 and 1917. Led by Lavalle, CAG used scientific studies of these events to repudiate the criticism that their mismanagement was the real cause for the marked decline in guano production during the company's first decade. This strategy was so successful that CAG was able to extend its authority to new parts of Peru's economy and coastal environment in the wake of these ecological disturbances. Of course, the guano birds did the real work of recovery. The guano, in particular, was adapted to reproduce quickly once El Niño conditions went away and upwelling resumed. CAG and its conservation ideals proved to be nearly as resilient.

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In 1925, a devastating El Niño event struck Peru and caused a marked decline in guano production.⁴⁷ Francisco Ballén, CAG's general manager since 1909, tried to pass the blame onto Peruvian fishermen. He jealously guarded CAG's monopoly control over the guano islands, and he rightly understood that a large fishing industry had the potential to hurt the guano birds by consuming their food. He had been trying for years to evict decades-old colonies of fisher folk from Lobos de Afuera and Lobos de Tierra and to prevent the Callao and Vicinity Fishermen's Union from obtaining concessions to fish within the two-mile

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exclusion zone surrounding all guano islands. In the wake of the 1925 disaster, he successfully convinced an old friend of CAG, President Leguía, to establish a Fishery Police under CAG's control in line with Forbes's 1913 report. This request fit Leguía's new political style: After barely winning a second term in 1919, he had used authoritarian means to rule what remained of the Aristocratic Republic. With the help of three gasoline-powered patrol boats custom-built in Europe, CAG's fishery police detained and helped prosecute several law-breaking fishermen.⁴⁸ As with so many conservation programs worldwide, the creation of guano island reserves criminalized many traditional practices and generated intense conflicts with competing users of Peru's marine environment. With Leguía's consent, CAG went to war to protect its nature sanctuaries from interloping fishermen.⁴⁹

Beginning in 1930, the guano industry faced a different sort of crisis. The Great Crash 40 caused Leguía's debt-fueled, eleven-year dictatorship to collapse—and forced Ballén to step down as CAG's general manager. As a hallmark of these changing times, Colonel Luis Sánchez Cerro transferred administration of CAG's Fishery Police to the maritime authority in 1931, and the Peruvian Armada expropriated its patrol boats. The institutional military recovered its monopoly over advanced weaponry as part of an unprecedented assertion of political power. CAG abruptly reached the limits of its political influence within the Peruvian government. But the gospel of efficiency on which CAG was founded proved adaptable to these new circumstances. In fact, Lavalle ended up with a higher administrative post.⁵⁰

Meanwhile, world prices for sugar and cotton collapsed. Peruvian farmers immediately 41 stopped purchasing fertilizer and other expensive inputs. But CAG quickly developed arrangements to provide farmers with easy, long-term credit for fertilizer purchases. This lending pattern led to the establishment of the Banco Agrícola, an institution that significantly improved the financial situation of small-and mid-sized farms during the 1930s. Credit made it possible for many new farms to adopt input-intensive practices, including a few in the Sierra; this began to reverse the socially regressive patterns of guano distribution during CAG's early years.⁵¹

This successful response to the Great Depression created unforeseen problems. Cotton 42 prices skyrocketed in the mid-1930s, and Peruvian farmers along the central and southern coast scrambled to convert their land holdings to cotton. CAG had no way to raise guano production to meet this new demand. It responded by trying to force farmers to use guano more efficiently: CAG rationed guano distribution to major purchasers, distributed propaganda discouraging waste, and created a commission of agronomic engineers to tour coastal farms and determine their fertilizer requirements. As a last resort, CAG raised the price for growers of export crops, while giving preference to smallholders and food crops. These policies marked a broad reorientation in the guano industry, reflecting the populist turn in Peruvian politics during the 1930s.⁵²

But CAG continued to rely on expert guidance. Building on past patterns of success, 43 CAG used its inflated profits to hire an ornithologist from the United States to study ways to increase guano production. As it turned out, CAG was able to acquire the services of William Vogt, a major figure in North American birding circles and a budding leader of the U.S. conservation movement. Unlike Coker and Lavalle, both university-trained professionals, Vogt acquired his scientific expertise as an avocational birder rubbing elbows in the museum and field with Ernst Mayr, Roger Tory Peterson, Robert Cushman Murphy, Margaret Morse Nice, and other New York-area scientists. Besides collaborating on published studies of local

marine birds, Vogt played an active role organizing larger-scale endeavors, such as the Audubon Society's Breeding Bird Census (est. 1937), that sought to understand, protect—and perhaps direct—the flow of migratory birds in North America.⁵³

Vogt carried two bibles with him to Peru, his close friend Aldo Leopold's *Game Management* and Charles Elton's *Animal Ecology*, and Vogt extended their influence to a vast new frontier.⁵⁴ Following their lead, Vogt implemented a "holistic" study of the guano birds and their environment during his three-year tenure in Peru. He set up the first large-scale banding project on the Peruvian coast, and he used aerial photos to make the first accurate bird census. Vogt's inspiration not only came from the far North, it also built on existing Peruvian research traditions. Following the precedent set by Lavalley, Vogt studied the microclimate of bird nesting behavior and confirmed that the birds preferred to nest in areas exposed to the prevailing winds.⁵⁵ 44

But Vogt had a difficult time studying the "normal" behavior of guano birds because the Peruvian coast was beset by an "ecological depression" of outstanding longevity. Late in 1939, an El Niño disrupted Vogt's early studies and caused massive nesting failure among the guano birds. This event lasted almost continuously for two more years and caused guano production to plunge to its lowest level since the 1917 El Niño. Vogt interpreted this climate event differently from his predecessors. Vogt commissioned an examination of "sick" guano birds by Peruvian pathologists and concluded they suffered from malnutrition. This confirmed Vogt's initial assumption, derived from reading Elton, that food supply was the major factor affecting guano bird population levels. Vogt also reassessed the ecological impact of CAG's island hygiene policies. He noted that CAG's rock-removal policy had eliminated the surface shelter that the four major predators of bird parasites, two spiders (*Drysderya murphyi* and *Loxosceles nesophila*) and two lizards (*Tropidurus peruvianus* and *Phyllodactylus* sp.), needed in order to regulate their body temperatures on sunny days. (There were plenty of ticks and hot, sunny days on the guano islands during this El Niño, much to Vogt's discomfort.) Vogt proposed installing hundreds of small concrete shelters to encourage "natural" pest control on the islands. Island cleaning had also removed material the birds needed to build nests, Vogt noted, and likely caused increased competition and fighting between the birds for scarce nest material. In other words, cleansing the islands to produce the purest guano possible may have made them too clean for the guano birds' health.⁵⁶ 45

Although Vogt found it easy to criticize existing practices, he was impressed by some of what he saw in Peru. Soon after this sojourn, he traveled to Chile and Mexico to help their governments establish local guano industries modeled after CAG. He also intervened to prevent a risky plan to transplant hundreds of guanay chicks from Peru to Baja California in order to replace the sargento guanero or Brandt's cormorant (*Phalacrocorax penicillatus*) with a more productive guano bird. To cement his legacy in Peru, Vogt arranged for his young assistant Enrique Ávila, a native of the Lake Titicaca region, to study wildlife management with Leopold in the United States. Ávila returned to CAG in 1946 as Peru's first professional, native-born ornithologist. He spent the rest of his career trying to instill Leopold and Vogt's environmental doctrines in his countrymen.⁵⁷ 46

Vogt was profoundly affected by his encounter with El Niño on the guano islands. Years later, he credited this event for converting him into an outspoken advocate of human population control: "Here was mass death in unforgettable shape and sound. Somehow, ever since, it has been possible to understand more fully the famines of China and India." Vogt 47

praised CAG—and technocratic governance—in his 1948 manifesto *Road to Survival*, the best-selling book on conservation issues in the United States before Rachel Carson's *Silent Spring*: "Were natural resources generally managed as intelligently as the Peruvians have—in this century—managed their guano, the future of the human race could be regarded with considerably more optimism." His experience with guano even led Vogt to exhort his homeland to "close the circle" and stop flushing away "Anglo-Saxon" feces, one of the world's last untapped sources of natural fertilizer.⁵⁸

In the meantime, CAG implemented a few of Vogt's suggestions. It used explosives to remove obstacles that blocked prevailing winds on the islands. CAG workers used the loose stone produced by these landscape alterations to build vast networks of containment walls designed to prevent hot, thirsty chicks from falling to their deaths in search of water and to discourage adult birds from launching themselves into the air from the edge of cliffs where their guano would be lost to the sea. (Vogt had observed that birds tend to defecate at take off.) 48

The most important policy change adopted by CAG after 1945, however, was originated by a new general manager, agronomic engineer Carlos Llosa Belaúnde. He used two of Vogt's main findings—food and competition for nesting space were the basic factors limiting the total size of the breeding population, and most birds migrated south during El Niño years when warm surface water flowed in from the north—to deduce that the guano birds lacked good nesting sites along several stretches of the Peruvian coast. He came up with a brilliant solution: CAG would create artificial "islands" along the southern and north-central coasts by building walls to isolate coastal points of land already frequented by roosting guano birds. Hunters then would eradicate avian and terrestrial predators from these havens. Llosa hoped the new islands would provide a breeding refuge during El Niño years and perhaps prevent the guanayes from "wasting" so much of their excrement over Chile. From 1946 to 1961, CAG built isolation walls around fourteen mainland points. (In a remarkable case of synchronicity, the South African government implemented a similar strategy along the Namibian coast during these years to expand the nesting area available to South Atlantic marine birds in order to increase the supply of guano to South African export wheat agriculture.)⁵⁹ Llosa's new "islands" worked much better than he expected. They allowed Peru's guano birds to surpass their former breeding limits during the 1950s, with the additional help of a long stretch of cool years with exceptionally intense upwelling (what scientists now call "La Niña" events). This case reveals the extent of local innovation that can follow the visit of foreign experts.⁶⁰ 49

In 1956, CAG produced an all-time record 332,223 metric tons of fresh guano containing 6,200 tons of potassium, 31,600 tons of phosphate, and 47,000 tons of nitrogen—over eleven times the amount of nitrogen supplied to Peruvian farmers in an average year during CAG's first decade of operation. This largesse of nature enabled Peruvian farmers to consume fertilizer in proportions nearly equaling the average for all "developed countries" of the First and Second Worlds, and far surpassing the rest of the Third World. As a result of long-standing changes in distribution policy, the majority of Peruvian guano went to produce food crops for local consumption — about a fifth went to smallholders, and a significant fraction (6.5 percent) went to farms in the Sierra. In 1956, CAG also made a net profit equivalent to \$17.2 million in 2005 U.S. dollars (down from \$25.4 million in 1955), even though CAG sold guano at regulated prices far below what the international market would bear. This income supported an elaborate scientific apparatus devoted not only to agronomy, but also to 50

oceanographic research. CAG officials also played an important role on the Comité Nacional de Protección a la Naturaleza, an organization of Peruvian scientists and agribusinessmen established in 1940 to advocate the establishment of wildlife protection laws, nature reserves, and national parks. Peru's guano birds became a source of international prestige and national pride, a true spectacle of nature.⁶¹

But there were storm clouds on the horizon. A consensus existed among CAG scientists 51 that the guano island "biome ha[d] arrived at its state of climax." They realized that the guano birds were pushing their resource base to the limit and that an "ecological depression" could happen at any time. But these worries paled before an emergent threat: the rapid development of an industrial fishery based on anchoveta (*Engraulis ringens*), the guano birds' main food source. Beginning after World War II, these small fish were caught in the billions; after the collapse of the California sardine industry, they were processed by the trillions to produce high-protein feed for the Northern Hemisphere's industrial animals.⁶² CAG's administrators realized the ecological threat this posed to the guano birds and incessantly lobbied Peru's government to place strict limits on the growth of the fishmeal industry. When CAG's stable of marine scientists failed to persuade the government, CAG invited marine bird expert Robert Cushman Murphy and sardine specialist Frances Clark—two of the United States' foremost conservation scientists—to study Peruvian marine production with "disinterest" and "affection for pure science." They warned that unregulated growth might "kill the hen that lays the golden egg" or repeat the "calamitous" history of the California sardine. In response, the Peruvian government adopted several experimental fishery regulations designed to protect the guano birds, despite vocal opposition from fishing industry experts. This was a small but meaningful achievement for the guano industry.⁶³

Then came the "ecological depression" CAG had long dreaded. El Niño returned in 1957 52 and stayed around until the end of 1958. After a decade of fat years, the inflated guanay and piquero populations withered. CAG had no way of feeding this enormous wild population. In desperation, CAG directed its workers to intensify their "prophylaxis" of the islands, eliminating bird cadavers and destroying the areas favored by bird ectoparasites in the futile hope that disease prevention might stem this holocaust. Inspired by Peruvian cotton farmers, who were among the first in the world to use DDT and other organo-insecticides on a large scale, CAG scientists even tried using Aldrin, benzene hexachloride (BHC), and other chemicals to get rid of parasites. Fortunately, these wrong-headed experiments failed: These chemicals are now known to cause egg-thinning, breeding failure, and direct poisoning in the very birds CAG was trying to protect.⁶⁴

The El Niño of 1957–1958 contributed to an economic crisis affecting the entire country. 53 President Manuel Prado initially issued much more rigorous fishery regulations to protect the guano birds while "biological studies ... determine the maximum yield possible that will protect the national economy." But then a new species of expert stepped into the breach to forestall the impending fiscal collapse of the Peruvian state. With crucial support from the International Monetary Fund, an avant-garde neoliberal economist, Pedro Beltrán, took over national economic planning in 1959 and decided to let the free market determine the fate of Peru's marine environment. He abolished all limitations on industrial development and installed policies encouraging exports. This provided an enormous boost to the Peruvian fishmeal industry whose spectacular growth, in turn, powered a rapid economic recovery. By 1962, Peru surpassed Japan as the largest fish-producing country by tonnage in the world. Meanwhile, a few daring chemical manufacturers tried to take advantage of the guano birds'

misfortune and opened Peru's first synthetic fertilizer plants. Yet it proved far more difficult and expensive than expected to replace the guano birds with modern chemical technology without the sort of protectionist policies Beltrán despised, especially after the guano. The guano birds proved the pessimists wrong and temporarily recovered from the disaster of 1957–1958, eroding the market for the nascent Peruvian chemical industry. In Beltrán's *Brave New World*, Peru's guano birds outcompeted the country's chemical engineers but faced an increasingly difficult task competing with Peru's industrial fishermen.⁶⁵

Peru's military could not tolerate this unplanned economic chaos with so many landless peasants pouring into Peru's cities and invading vacant lots, and with left-wing guerrilla movements springing up in the countryside in the wake of the 1959 Cuban Revolution. Reform-minded military officers took control of the Peruvian state for several months in 1962–1963. In one of the ironic twists of ecological history, military technocrats used William Vogt's most influential contribution to modern environmental thought—the belief that human population growth was outstripping its food supply and threatening apocalypse—to legitimate the replacement of Peru's guano birds. In their view, only a synthetic fertilizer industry not subject to recurrent ecological depressions could supply the growing fertilizer demand of Peru's exploding human population. Military planners immediately began hiring foreign experts to construct Peruvian fertilizer plants based on the Haber-Bosch process. CAG was renamed the *Corporación Nacional de Fertilizantes (CONAFER)* in 1963 to reflect this new vision. Using similar reasoning, defenders of Peru's gargantuan fishing industry claimed they were helping to feed the world's hungry by exploiting a lower trophic level of Peru's marine food chain. According to the gospel of efficiency, fishermen made far better use of natural resources than Peru's "anachronistic" guano birds. To back up these lofty claims, Peru's fishmeal industrialists began funneling large sums to support Peru's new Institute of the Sea (*IMARPE*) which was established in 1964 and soon became one of the world's centers of marine research. The industrialists cynically deemphasized the fact, however, that 99 percent of Peru's yearly catch went to produce meat for affluent northerners.⁶⁶

With competition for fish increasing by the day, Peru's guano birds died quite visibly during the next El Niño. In the summer of 1965, tens of thousands of starving sea birds descended on the open markets of Peru's coastal cities looking for food. This inspired enormous public outcry both in Peru and abroad, especially among those disgusted by the environmental horrors of Peru's coastal cities, which had become choked with industrial fumes and effluent smelling like dead fish. Many Peruvians had come to view the guano birds as symbols of national independence. This popular environmental consciousness was an important legacy of the guano industry's revival.⁶⁷

By 1965, a civilian government had returned to power. President Fernando Belaúnde, a former architecture professor with conflicting populist and technocratic tendencies, responded to public clamor by strengthening enforcement of laws to protect the guano industry. But this was a short-term response: He granted power to a government commission of experts to develop a long-term solution. Many Peruvians still thought of the guano birds as "the most valuable birds in the world." The agronomists who led CONAFER and the Ministry of Agriculture eloquently defended this point of view. But all those who really counted thought otherwise. Why should Peru rein in its most lucrative new industry in order to save the guano birds, particularly when Peru's expensive new fertilizer plants were having trouble selling their wares?⁶⁸

But developmentalist arguments did not win the day for the fishing industry. Conservationist arguments did. As a paid consultant to the fishing industry, U.S. biologist Milner B. Schaefer, the world's leading expert on fish population dynamics, developed a method to include guano bird predation in his anchoveta population model. Using computers, he quantified exactly how much Peru stood to benefit from the demise of the guano birds. Furthermore, Schaefer authoritatively blamed the guano birds' "catastrophic mortality" in 1965 on El Niño conditions, not to competition from fishing. His "objective cost-benefit analysis" converted Coker's "wealth-producing birds" into predatory pests. With Schaefer's guidance, fishing industry executives and Peruvian marine scientists developed a plan to give scientists regulatory control over the fishmeal industry to ensure a "maximum sustainable yield" for human benefit. This sealed the guano birds' fate. In 1966, the Peruvian government stopped enforcing regulations protecting the guano birds from the fishing industry, and the fishing industry submitted for the first time to a series of limitations recommended by IMARPE to protect anchoveta stocks. Against their better instincts, the guano birds abided by their part of the deal and have held their population at no more than a few million ever since. The gospel of efficiency ended up condemning the Peruvian guano industry to its second Dark Age.⁶⁹

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At least for Peru, this was no "age of ecological innocence."⁷⁰ In the case of the guano birds, ecological thinking inspired a crime against nature intended to forestall an apocalypse caused by human overpopulation. Similar thinking legitimated the embrace of input-intensive agriculture elsewhere in the world, including the massive use of synthetic pesticides attacked by Rachel Carson in *Silent Spring*. It also legitimated the emergence of "bureaucratic-authoritarian" military regimes elsewhere in Latin America far more brutal than Peru's reformist military. How then, with this tragic denouement, can the revival of Peru's guano industry be called a success?

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The second rise and fall of Peru's guano industry is a story of managerial accomplishment, though perhaps it is a story distasteful to most environmentalists. International conservation scientists emerged from this controversy with regulatory authority over the largest fishing industry in the world. The guano industry paled in comparison as a producer of wealth—and of excrement. (The vast "animal factories" fishmeal helped make possible have come to possess a dangerous propensity to produce vast concentrations of animal waste.)⁷¹ In view of the guano industry's ability to serve so many interests and survive so many crises across five decades, it became all the more plausible for military technocrats to envision themselves as the only men capable of directing Peru's chaotic development.

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But authoritarian technocrats overreached in Peru. In 1968, the Revolutionary Government of the Armed Forces seized control of the Peruvian state—then Peru's agribusiness, mines, and fishing industry—and stayed in charge for twelve years. In managing these industries, military technocrats lost sight of some significant details, such as the El Niño phenomenon. Unfortunately, in the case of Peru's anchoveta fishery, it proved far more difficult to manage an industry that depended on killing most of its own breeding stock each year than it did to provide birds with enough peace and quiet to cover entire islands with the world's most valuable poop.⁷² Is it any wonder that so many of the world's environmental movements—from the United States' dam-busters, to Japan's Minamata survivors, to Germany's Burger Initiativen, to India's Chipko protestors—rejected state managerialism? Is it any wonder that the scientists who founded Peru's Committee for the Protection of Nature became so depressed during the 1970s? Perhaps this case provides us all the more reason to

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be concerned that "ecocrats" now present themselves as the only ones qualified to accomplish "sustainable development" or mitigate global climate change.⁷³

Nevertheless, spring is not yet silent on Peru's guano islands. A few million guano birds remain. More importantly, a few people still remember the glory days of Peru's second Guano Age. Despite the enormous competition from Peru's fishing industry, a small expert-managed government company, PROABONOS, continues to shepherd Peru's remaining guano birds—to serve high-value organic farming and ecotourists.⁷⁴ Perhaps with a few more environmental success stories to serve as examples, this could mark the beginning of Peru's third Guano Age. 61

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NOTES

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⁴ Wines, *Fertilizer in America*; Jimmy M. Skaggs, *The Great Guano Rush: Entrepreneurs and American Overseas Expansion* (New York: St. Martin's Press, 1994); Carmen McEvoy, *La utopía republicana: Ideales y realidades en la formación de la cultura política peruana (1871–1919)* (Lima: Pontificia Universidad Católica del Perú, 1997), esp. chs. 3–5.

⁵ Recent studies have shown that many features of the U.S. conservation movement were not peculiar to the United States: most notably, the essential influence of science professionals, many of whom were empowered to serve the interests of resource exploiters. See Samuel P. Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890–1920* (Cambridge: Harvard University Press, 1959); Michael L. Lewis, *Inventing Global Ecology: Tracking the Biodiversity Ideal in India, 1947–1997* (Athens: Ohio University Press, 2004); Stuart McCook, *States of Nature: Science, Agriculture, and Environment in the Spanish Caribbean, 1760–1940* (Austin: University of Texas Press, 2002); Peder Anker, *Imperial Ecology: Environmental Order in the British Empire, 1895–1945* (Cambridge: Harvard University Press, 2001); Richard Drayton, *Nature's Government: Science, British Imperialism, and the "Improvement of the World"* (New Haven: Yale University Press, 2000); Thomas R. Dunlap, *Nature and the English Diaspora: Environment and History in the United States, Canada, Australia, and New Zealand* (Cambridge: Cambridge University Press, 1999), chs. 5–6, 8; John M. MacKenzie, *The Empire of Nature: Hunting, Conservation, and British Imperialism* (Manchester: Manchester University Press, 1988); and Douglas R. Weiner, *Models of Nature: Ecology, Conservation, and Cultural Revolution in Soviet Russia* (Bloomington: Indiana University Press, 1988).

⁶ Nancy Stepan, *Beginnings of Brazilian Science: Oswaldo Cruz, Medical Research and Policy, 1890–1920* (New York: Science History Publications, 1981), 8–9; and Julian G. Peard, *Race, Place, and Medicine: The Idea of the Tropics in Nineteenth-Century Brazil* (Durham, N.C.: Duke University Press, 2000).

⁷ "Anexos: Guano explotado ... durante los años 1909–1962," *Memoria del Directorio de la Compañía Administradora del Guano* (Lima) [hereafter, MCAG] 54 (1963); Humberto Tovar, "Las poblaciones de aves guaneras en los ciclos reproductivos de 1969/70 a 1973/ 74," *Informe del Instituto del Mar del Perú* [hereafter, Inf.Inst.Mar Perú] 45 (1978): 12; Felipe Portocarrero, Arlette Beltrán, and María Elena Romero, *Compendio estadístico del Perú, 1900–1990* (Lima: Universidad del Pacífico, Centro de Investigación, 1992), 88–89.

⁸ This case contrasts starkly with Arthur F. McEvoy's portrayal of the demise of California's sardine fishery as based on the failure of scientists to recognize the volatility and complexity of the Pacific environment. See Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850–1980* (Cambridge: Cambridge University Press, 1986). "All things dull and ugly, / All creatures short and squat, / All things rude and nasty, / The Lord God made the lot." Eric Idle, *Monty Python Sings*, Virgin Records CDVirg 86253.

⁹ Robert Cushman Murphy, "Inter-American Conservation," *Bird-Lore* (May-June 1940): 226. Two North American historians, Charley Stansifer and Eric Mills, have recounted to me their vivid recollections of this sublime sight. Murphy has no known relation to the author.

¹⁰ On William Vogt's far-reaching influence, see Björn-Ola Linnér, *The Return of Malthus: Environmentalism and Post-war Population Resource Crises* (Stroud, England: White Horse Press, 2003). I develop this story in much greater detail in a separate article tentatively titled "The Road to Survival: William Vogt, Population Ecology, and the Peruvian Roots of Modern Environmentalism."

¹¹ On the "ubiquitous rise" of experts to power in Latin America and beyond, see Miguel A. Centeno and Patricio Silva, eds., *The Politics of Expertise in Latin America* (New York: St. Martin's Press, 1998); Miguel A. Centeno, "The New Leviathan: The Dynamics and Limits of Technocracy," *Theory and Society* 22 (1993): 307–35; and John Markoff and Verónica Montecinos, "The Ubiquitous Rise of Economists," *Journal of Public Policy* 13 (1993): 37–

68. On the influence of scientists over recent environmental politics, see Clark A. Miller and Paul N. Edwards, eds., *Changing the Atmosphere: Expert Knowledge and Environmental Governance* (Cambridge: MIT Press, 2001); Sheila Jasanoff, *The Fifth Branch: Science Advisors as Policy Makers* (Cambridge: Harvard University Press, 1990).

¹² Rory Miller, "The Grace Contract, The Peruvian Corporation, and Peruvian History," *Ibero-Amerikanisches Archiv*, n.s., 9 (1983): 319-48; Rory Miller, "The Making of the Grace Contract: British Bondholders and the Peruvian Government, 1885-1890," *Journal of Latin American Studies* 8 (1976): 73-100; Rory Miller, "British Firms and the Peruvian Government, 1885-1930," in *Business Imperialism, 1840-1930: An Inquiry Based on British Experience in Latin America*, ed. D. C. H. Platt (Oxford: Clarendon Press, 1977), 371-94.

¹³ Rory Miller, "The Coastal Elite and Peruvian Politics, 1895-1919," *Journal of Latin American Studies* 14 (1982): 97-120; and Peter F. Klarén, "The Origins of Modern Peru, 1880-1930," in *The Cambridge History of Latin America*, ed. Leslie Bethell, 11 vols. (Cambridge: Cambridge University Press, 1986), 5: 587-640.

¹⁴ José I. Otero, "Generalidades sobre la costa del Perú," *Boletín del Ministerio de Fomento [hereafter, BMFom]* (Lima) 4 (August 1906): 35-41; *Memoria del Ministerio de Fomento [hereafter, MMFom]* 12 (1908): 12-13, 18; Rosemary Thorp and Geoffrey Bertram, *Peru, 1890-1977: Growth and Policy in an Open Economy* (London: Macmillan, 1978), pt. 2; Rory Miller, "Railways and Economic Development in Central Peru, 1890-1930," in *Social and Economic Change in Modern Peru*, ed. Rory Miller, Clifford T. Smith, and John Fisher (Liverpool: Center for Latin American Studies, 1975), 27-52; Marcos Cueto and Jorge Lossio, *Inovación en la agricultura: Fermin Tangüis y el algodón en el Perú* (Lima: Centro de Investigación de la Universidad del Pacífico, 1999). Compare to Richard P. Tucker, *Insatiable Appetite: The United States and the Ecological Degradation of the Tropical World* (Berkeley and Los Angeles: University of California Press, 2000).

¹⁵ *MMFom* 1 (1896): 3, 7-8, 70; Marcos Cueto, *Excelencia científica en la periferia: Actividades científicas e investigación biomédica en el Perú, 1890-1950* (Lima: CONCYTEC, 1989), ch. 2; Jesús Chavarría, "The Intellectuals and the Crisis of Modern Peruvian Nationalism, 1870-1919," *Hispanic American Historical Review* 50 (1970): 25778; Charles Hale, "Political and Social Ideas in Latin America, 1870-1930," in *Cambridge History of Latin America*, ed. Bethell, 4:367-41; see also n. 5.

¹⁶ See [Figure 1](#) for a partial chronology of significant El Niño events. Robert Cushman Murphy, *Bird Islands of Peru: The Record of a Sojourn on the West Coast* (New York: G.P. Putnam's Sons, 1925), 62; Robert Cushman Murphy, "The Oceanography of the Peruvian Littoral with Reference to the Abundance and Distribution of Marine Life," *Geographical Review* 13 (1923): 64-85; George Evelyn Hutchinson, "Survey of Existing Knowledge of Biogeochemistry: 3. The Biogeochemistry of Vertebrate Excretion," *Bulletin of the American Museum of Natural History* 96 (1950): 71-78; and Michael H. Glantz, *Currents of Change: Impacts of El Niño and La Niña on Climate and Society*, 2nd ed. (Cambridge: Cambridge University Press, 2001), esp. ch. 3.

¹⁷ See the October-November 1853 reports to the Peruvian government reprinted in *Boletín de la Compañía Administradora del Guano* (Lima) [hereafter, *BCAG*] 4 (March 1928): 155-94. For a noteworthy precedent, see Rose Marie Buechler, "Technical Aid to Upper Peru: The Nordenflicht Expedition," *Journal of Latin American Studies* 5 (1973): 37-77.

¹⁸ Using cladistic and DNA evidence, recent taxonomists have tended to classify the guanay as a shag (*Leucocarbo*), though they are undecided whether shags qualify as a subfamily, genera, or subgenera separate from "true" cormorants. In contrast, recent taxonomists have tended to lump together all brown pelicans of the Americas as subspecies of *P. occidentalis*. Robert Cushman Murphy, *Oceanic Birds of South America*, 2 vols. (New York: MacMillan, 1936), 1: 94-108, 2: 819-46, 899-909; Paul A. Johnsgard, *Cormorants, Darters, and Pelicans of the World* (Washington, D.C.: Smithsonian Institution Press, 1993), 10-13, 15-16, 249-52, 387-97.

¹⁹ *MMFom* 10 (1906): xxiv; *BMFom* 4 (July 1906): 7, 93; Robert E. Coker, "Aves guaneras y extracción de guano," *MMFom* vol. 12, anexos 161, 162 (1908): 5-30; Robert E. Coker, "Regarding the Future of the Guano Industry and the Guano-Producing Birds of Peru," *Science* (10 July 1908): 59; H. Eugene Lehman, "Robert Ervin Coker, 1876-1967," *The Journal of the Elisha Mitchell Scientific Society* 84 (Summer 1968): 333-34; George Lee Simpson, Jr.,

The Cokers of Carolina: A Social Biography of a Family (Chapel Hill: University of North Carolina Press, 1956), 247-49.

²⁰ Coker, "Aves guaneras"; Coker, "Regarding the Future," 58-64.

²¹ "La Extracción y venta del guano: Información de una compañía," *La Prensa* (Lima), 3 March 1909 (morning ed.), 1; *Estatutos de la Compañía Administradora del Guano* [hereafter, *ECAG*] (Lima, 1923), 5, 15-16, 29-31; *MCAG* 5 (1914): 23; Pablo Macera, "El guano y la agricultura peruana de exportación, 1909-1945," in *Trabajos de historia*, 4 vols. (Lima: Instituto Nacional de Cultura, 1977), 4:324-30.

²² *MCAG* 3 (1912): 3, 47, 49; *MCAG* 5 (1914): 29.

²³ *MCAG* 5 (1914): 29-41, 45-58, 51-53.

²⁴ *Ibid.*, 44; *MCAG* 3 (1912): 5, 44; Walter von Ohlendorff, *Die Guano-Fundorte in Peru: Photographische Originalaufnahmen der Anglo-Continentalen Guano-Werke, Hamburg, Emmerich, Antwerpen, London* (Hamburg: 1903); "Forbes, Dr. Henry Ogg," *Who Was Who, 1929-1940: A Companion to Who's Who Containing the Biographies of Those Who Died during the Period 1929-1940* (London: Adam & Charles Black, 1941); H. O. Forbes, *A Naturalist's Wanderings in the Eastern Archipelago: A Narrative of Travel and Exploration from 1878 to 1883* (London: S. Low, Marston, Searle & Rivington, 1885), 51-117. See also Mike Davis, *Late Victorian Holocausts: El Niño Famines and the Making of the Third World* (London: Verso, 2001), pt. 1.

²⁵ *MCAG* 5 (1914): 67, 70-72, 86-91; *MCAG* 12 (1921): 34.

²⁶ *MCAG* 5 (1914): 93-101.

²⁷ *MCAG* 7 (1916): iv, 86-87; CAG, Sección Técnica, *Las necesidades de guano de la agricultura nacional: Informe presentado por el jefe de la sección Ingeniero Agrónomo Sr. José Antonio de Lavalle y García* (Lima: Librería e Imprenta Gil, 1916), 13-16; Macera, "El guano," 388, 396-401.

²⁸ Murphy, *Bird Islands*, 66, 69; Vaclav Smil, *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production* (Cambridge: MIT Press, 2001), esp. chs. 4-5; Miller, "British Firms and the Peruvian Government," 382, 386; Macera, "El guano," 334.

²⁹ See Manuel Burga and Alberto Flores Galindo, *Apogeo y crisis de la República Aristocrática: Oligarquía, aprismo y comunismo en el Perú, 1895-1932*, 3rd ed. (Lima: Ediciones Rikchay Perú, 1984); Manuel Perlo Cohen, *El paradigma porfiriano: Historia del desajuste del Valle de México* (Mexico City: Miguel Ángel Porrúa, 1999); Lane Simonian, *Defending the Land of the Jaguar: A History of Conservation in Mexico* (Austin: University of Texas Press, 1995), chs. 3-5; Teresa A. Meade, *"Civilizing" Rio: Reform and Resistance in a Brazilian City, 1889-1930* (University Park: Pennsylvania State University Press, 1997), ch. 3; and José Drummond, "The Garden in the Machine: An Environmental History of Brazil's Tijuca Forest," *Environmental History* 1 (January 1996): 83-104.

³⁰ Stephen R. Gliessman, *Agroecology: Ecological Processes in Sustainable Agriculture* (Chelsea, Mich.: Sleeping Bear Press, 1998); and Donald Worster, "Transformations of the Earth: Toward an Agroecological Perspective in History," *Journal of American History* 76 (1990): 1087-1106.

³¹ In industrial France and the colonial Philippines, in contrast, experts used similar means to rid the human environment of dangerous excrement and maximize industrial production and consumption. See Jean-Pierre Goubert, *The Conquest of Water: The Advent of Health in the Industrial Age*, trans. Andrew Wilson (Princeton: Princeton University Press, 1989); and Warwick Anderson, "Excremental Colonialism: Public Health and the Poetics of Pollution," *Critical Inquiry* 21 (Spring 1995): 640-69. On the global spread of scientific management, see Deborah Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture* (New Haven: Yale University Press, 2003); William M. Tsutsui, *Manufacturing Ideology: Scientific Management in Twentieth-Century*

Japan (Princeton: Princeton University Press, 1998); Barbara Weinstein, *For Social Peace in Brazil: Industrialists and the Remaking of the Working Class in São Paulo, 1920–1964* (Chapel Hill: University of North Carolina Press, 1996); and Lewis H. Siegelbaum, *Stakhanovism and the Politics of Productivity in the USSR, 1935–1941* (Cambridge: Cambridge University Press, 1988). On its ties to ecology, see Gregg Mitman, *The State of Nature: Ecology, Community, and American Social Thought, 1900–1950* (Chicago: University of Chicago Press, 1992).

³² Murphy, *Bird Islands*, 66, 69, 278; *MCAG* 6 (1915): vii; *MCAG* 33 (1942): xliii; *MCAG* 12 (1921): 84; *MCAG* 13 (1922): 37; *MCAG* 17 (1926): 11; *MCAG* 22 (1931): 208; *MCAG* 27 (1936): 180; *MCAG* 33 (1942): xliii, xlv; and Humberto Tovar, Victor Guillén, and María E. Nakama, "Monthly Population Size of Three Guano Bird Species off Peru, 1953 to 1982," in *The Peruvian Anchoveta and Its Upwelling Ecosystem: Three Decades of Change*, ed. D. Pauly, et al. (Callao: Instituto del Mar del Perú, 1987), 208–18.

³³ These conclusions are based on an island schedule I constructed for this entire period using yearly reports in *MCAG*. Compare to Luis Gamarra Dulanto, "Informe sobre las investigaciones de pérdida de nitrógeno en los guanos," *BCAG* 18 (September 1942): 283–98. For critiques of CAG's rotation policy, see Robert E. Coker, "Peru's Wealth-Producing Birds," *National Geographic Magazine* (June 1920): 559; *MCAG* 8 (1917): 31–37; *MCAG* 18 (1927): 222–30; *MCAG* 12 (1921): 11; *MCAG* 14 (1923): xii; and *MCAG* 15 (1924): xiii.

³⁴ Each *MCAG* during this period lists all operating guard stations. See also *MCAG* 17 (1926): 120–21; *MCAG* 19 (1928): 271–74; Antonio Raimondi, "Apuntes sobre el huano y las aves que lo producen," *BCAG* 2 (Sept. 1926): 450, [originally published 1856]; Coker, "Peru's Wealth-Producing Birds," 557–58; Murphy, *Bird Islands*, 266–68, 276–77; Murphy, *Oceanic Birds*, 1: 292–93, 453–54, 2: 774–75, 778, 877; David Cameron Duffy, Coppelias Hays, and Manuel A. Plenge, "The Conservation Status of Peruvian Seabirds," in *Status and Conservation of the World's Seabirds*, ed. J. P. Croxall, P. G. H. Evans, and R. W. Shreiber (Cambridge: International Council for Bird Preservation, 1984), 246, 253; and C. Hilton-Taylor, ed., *2000 IUCN Red List of Threatened Species* (Gland, Switzerland and Cambridge, UK, 2000), <http://www.redlist.org/search/details.php?species=16485> [also species=16832, 20609].

³⁵ Murphy, *Bird Islands*, 88–89, 122–23, 204–6, 282–83, 287–89; Murphy, *Oceanic Birds of South America*, 2:1013–16, 1052–71; *MCAG* 6 (1915): vii; *MCAG* 8 (1917): ix, 43–46; *MCAG* 9 (1918): 9; *MCAG* 13 (1922): 53; and *ECAG*, 16, 50–51.

³⁶ *Informe que sobre la Compañía Administradora del Guano eleva al Supremo Gobierno por conducto del Ministerio de Hacienda, la Comisión nombrada por Resolución Suprema de 18 de Junio de 1941* (Lima: Librería e Imprenta Gil, 1942), 32, 46, 50, 66; William Vogt journal, Isla Santa Rosa, 5 May 1939, William Vogt papers, Denver Public Library, Denver, Colo., box 3:1 [hereafter, Vogt papers]; *MCAG* 44 (1953): iii–vi; Duffy, Hays, and Plenge, "The Conservation Status of Peruvian Seabirds," 251; and Hilton-Taylor, ed., *2000 IUCN Red List of Threatened Species* [species=40258]. For a discussion of conservationist's changing attitude toward "varmints," see Thomas R. Dunlap, *Saving America's Wildlife* (Princeton: Princeton University Press, 1988); and Donald Worster, *Nature's Economy: A History of Ecological Ideas*, 2nd ed. (Cambridge: Cambridge University Press, 1994), ch. 13.

³⁷ Murphy, *Bird Islands*, 79; Raúl Palacios Rodríguez, *Historia marítima del Perú* (Lima: Instituto de Estudios Histórico-Marítimos del Perú, 1991), bk. 12, vol. 2, p. 346; Robert E. Coker, "La caza de lobos en el Perú," *BCAG* 9 (August 1933): 224, 234–37; "La caza de lobos y pesca de ballenas y bufeos en el Perú," *BMFom* 5 (December 1907): 64–95; "Encomendando a la Compañía la caza de lobos del mar," *BCAG* 12 (August 1936): 340; Erwin Schweigger, "Informe sobre la caza de lobos del mar," *BCAG* 16 (September 1940): 296–97; William Vogt, "Los lobos y las aves guaneras," *BCAG* 15 (October 1939): 397–99; Alberto González Zúñiga, "Lobos marinos: Fuente de riqueza," *BCAG* 20 (May 1944): 12733; and Peter Muck and Humberto Fuentes, "Sea Lion and Fur Seal Predation on the Peruvian Anchoveta, 1953–1982," in *The Peruvian Anchoveta*, ed. Pauly, 234–47.

³⁸ On biomedical trends in Peru, see Cueto, *Excelencia científica en la periferia*; Cueto, "Andean Biology in Peru: Scientific Styles in the Periphery," *Isis* 80 (1989): 640–58. See also McCook, *States of Nature*, esp. 21–22, 78–79, 82–102; Meade, "Civilizing" Rio; Peard, *Race, Place, and Medicine*; and Stepan, *Beginnings of Brazilian Science*.

³⁹ José Antonio de Lavalle y García, "Informe preliminar sobre la causa de la mortalidad anormal de las aves ocurrida en el mes de marzo del presente año," *MCAG* 8 (1917): 6188; *MCAG* 8 (1917): ix, 32; *ECAG*, 16; *MCAG* 12 (1921): 11; *MCAG* 15 (1924): 108; *MCAG* 19 (1928): 254-55; Luis Gamarra Dulanto, "Los peligros que implica la cría de aves de corral en las islas guaneras," *BCAG* 10 (January-April 1934): 43-44; Raúl Rebagliati, "Informe sobre recientes enfermedades de las aves," *BCAG* 12 (May 1936): 149-54; and U.S. Department of the Interior, U.S. Geological Survey, National Wildlife Health Center, "Fact Sheet: Avian Cholera," (2001)

http://www.nwhc.usgs.gov/whats_new/fact_sheet/fact_cholera.html.

⁴⁰ *MCAG* 9 (1918): 14; *MCAG* 12 (1921): 14; *MCAG* 14 (1923): xv-xvi; *MCAG* 17 (1926): xx; Coker, "Peru's Wealth-Producing Birds," 562, 564; and Murphy, *Bird Islands*, 96.

⁴¹ *MCAG* 9 (1918): 12; *MCAG* 14 (1923): xv-xvi; *MCAG* 15 (1924): xix-xx; *MCAG* 17 (1926): 54; *MCAG* 23 (1932): xvii; *MCAG* 27 (1936): 241-48; Vogt journal, Isla Santa Rosa, 5 May 1939, photograph, August 1939, roll 29, Vogt papers, box 3:1, 4:1; Robert Cushman Murphy, "Los invertebrados terrestres de las islas guanera," *MCAG* 12 (1921): 95-116; M. Federico Ocampo, "Las condiciones sanitarias de las islas del sur: Informe presentado por el Doctor M. Federico Ocampo, médico de las islas del sur, a la Compañía Administradora del Guano al finalizar la campaña 1924-1925," *BCAG* 2 (January 1926): 37-52; and F. García Llaque, "Contribución al estudio de las condiciones higiénicas de la industria del guano de las islas," *BCAG* 18 (November 1942): 343-401. Compare to Florencia Mallon, *The Defense of Community in Peru's Central Highlands: Peasant Struggle and Capitalist Transition, 1860-1940* (Princeton: Princeton University Press, 1983), and n. 46 below.

⁴² See reports filed in Archivo de Admón, Zona Norte, preserved by PROABONOS, Callao; Murphy, *Bird Islands*, 341-42; Macera, "El guano," 419-20.

⁴³ Adulteration of guano had been a perennial problem for farmers: see Wines, *Fertilizer in America*, 126-35. *MCAG* 3 (1912): 4-5, 43; *MCAG* 9 (1918): 12; *MCAG* 11(1920): xiii, 1; *MCAG* 17 (1926): xiv, xx; *MCAG* 22 (1931): xiv; *MCAG* 23 (1932): i, xvi; Coker, "Peru's Wealth-Producing Birds," 564. *MCAG* 29 (1938): xv-xvii, clearly show the amount of integration CAG developed over three decades. Compare to Theodore Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (Princeton: Princeton University Press, 1995).

⁴⁴ "Lavalle y García, José Antonio de" *Diccionario biográfico de peruanos contemporáneos*, ed. Juan Pedro Paz-Soldán (Lima: Librería e Imprenta Gil, 1917, 1921); *MCAG* 3 (1912): 59; *MCAG* 8 (1917): xii; *MCAG* 13 (1922): 14; *MCAG* 14 (1923): xiv, 11; *MCAG* 17 (1926): xvi-xvii, 14; *MCAG* 20 (1929): xiv; *MCAG* 23 (1932): xiv; and CAG, Sección Técnica, *Las necesidades de guano*. For a directory of the *Boletín's* international distribution, see *BCAG* 2 (November 1926): 592-606. On the abstraction process involving wheat agriculture, see William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton, 1991), ch. 3.

⁴⁵ CAG, Sección Técnica, *Las necesidades de guano*, 117-205, 209-40, graph following p. 294; "Anexos: Detalle de la distribución y venta del guano en los puertos," *MCAG* 3-26 (1912-1935); "Anexos: Clasificación de las ventas de guano a la agricultura nacional y su contenido en unidades de nitrógeno," *MCAG* 26, 33 (1935, 1942); *MCAG* 12 (1921): 15; *MCAG* 13 (1922): 8-9; and *MCAG* 14 (1923): 55-57.

⁴⁶ Michael J. Gonzales, "Planters and Politics in Peru, 1895-1919," *Journal of Latin American Studies* 23 (1991): 515-31; Michael J. Gonzales, *Plantation Agriculture and Social Control in Northern Peru, 1875-1933* (Austin: University of Texas Press, 1985); Vincent C. Peloso, *Peasants on Plantations: Subaltern Strategies of Labor and Resistance in the Pisco Valley, Peru* (Durham, N.C.: Duke University Press, 1999), esp. 118-19; and José Carlos Mariátegui, *Seven Interpretive Essays on Peruvian Reality*, trans. Marjory Urquidí (1928; reprint, Austin: University of Texas Press, 1971), ch. 3.

⁴⁷ *MCAG* 18 (1927): ii, x; *MCAG* 22 (1931): xiv. See Gregory T. Cushman, "Enclave Vision: Foreign Networks in Peru and the Internationalization of El Niño Research during the 1920s," *History of Meteorology* 1 (2004): 65-74, available at <http://www.meteohistory.org/2004proceedings1.1.>

⁴⁸ *ECAG*, 47, 49-50, 55, 61-64; *MCAG* 12 (1921): 54-57; *MCAG* 13 (1922): 72; *MCAG* 14 (1923): 19-23; *MCAG*

15 (1924): 79–83; *MCAG* 16 (1925): xiii, 11–38; *MCAG* 17 (1926): xv-xvi; and *MCAG* 20 (1929): xi-xiii, 258–63.

⁴⁹ See, for example, Karl Jacoby, *Crimes Against Nature: Squatters, Poachers, Thieves, and the Hidden History of American Conservation* (Berkeley and Los Angeles: University of California Press, 2001); Stephan Amend and Thora Amend, eds., *National Parks without People? The South American Experience*, trans. Lilian de Croce and Christopher Canaday (Quito, Ecuador: IUCN/Parques Nacionales y Construcción Ambiental, 1995); Jonathan S. Adams and Thomas O. McShane, *The Myth of Wild Africa: Conservation without Illusion* (New York: W.W. Norton, 1992).

⁵⁰ *MCAG* 22 (1931), xv-xvi; *MCAG* 23 (1932): 217–20; *MCAG* 25 (1934): xi; and *MCAG* 26 (1935): xiii, 269–70. On the "desertion of the elites" and rise of mass politics during these years, see Steve Stein, *Populism in Peru: The Emergence of the Masses and the Politics of Social Control* (Madison: University of Wisconsin Press, 1980).

⁵¹ *MCAG* 23 (1932): v; *MCAG* 27 (1936): ix, xiv; and Thorp and Bertram, *Peru, 1890–1977*, 175, 177, 198–99.

⁵² Thorp and Bertram, *Peru, 1890–1977*, 170–72; *MCAG* 26 (1935): v, 237, 244–45, 339; *MCAG* 27 (1936): vii, ix, 183; *MCAG* 29 (1938): vii, ix, 240; *MCAG* 30 (1939): iv, vi-vii, 50–55; *MCAG* 33 (1942): iv; and "Importante: Instrucciones para la buena conservación y aprovechamiento del guano," *BCAG* 11 (November 1935): 511.

⁵³ "Some Notes on WV for Mr. Best to Use as He Chooses in Connection with a Possible Article," n.d., Vogt papers, box 5:1; Mark V. Barrow, *A Passion for Birds: American Ornithology after Audubon* (Princeton: Princeton University Press, 1998), esp. 171, 179, 190–94, 259 n. 145; Frank Graham, Jr., *The Audubon Ark: A History of the National Audubon Society* (New York: Alfred A. Knopf, 1990), 117–18, 133–34, 142–44; Robert Cushman Murphy and William Vogt, "The Dovekie Influx of 1932," *The Auk* 50 (July 1933): 325–49; William Vogt, "Preliminary Notes on the Behavior and the Ecology of the Eastern Willet," *Proceedings of the Linnaean Society of New York* 49 (October 1938): 8–42. Compare to Robert M. Wilson, "Directing the Flow: Migratory Waterfowl, Scale, and Mobility in Western North America," *Environmental History* 7 (April 2002): 247–66.

⁵⁴ Several recent histories have traced the far-reaching international influence of Elton's "Oxford School of Imperial Ecology" on ecological theory and the practice of animal management; some are beginning to address Leopold's practical impact: Anker, *Imperial Ecology*; Dennis Chitty, *Do Lemmings Commit Suicide? Beautiful Hypotheses and Ugly Facts* (New York: Oxford University Press, 1996); Peter Crowcroft, *Elton's Ecologists: A History of the Bureau of Animal Population* (Chicago: Chicago University Press, 1991); Dunlap, *Saving America's Wildlife*.

⁵⁵ *MCAG* 30 (1939): x, 64–65; William Vogt, "Enumeración preliminar de algunos problemas relacionados con la producción del guano en el Perú," *BCAG* 15 (July 1939): 287–89; William Vogt, "Informe anual del ornitólogo," *BCAG* 16 (May 1940): 145–68; José Antonio de Lavalle y García, "Estudio sobre los factores que influyen sobre la distribución de los nidos de aves productoras de guano," *MCAG* 9 (1918): 207–13.

⁵⁶ Vogt, "Enumeración preliminar," 293–94; Vogt, "Informe anual del ornitólogo," 150–52, 158–59; William Vogt, "Una depresión ecológica en la costa peruana," *BCAG* 16 (October 1940): 307–29; William Vogt, "Aves guaneras," *BCAG* 17 (April 1941): 128, 130, 133, 135, 137–38, 167; William Vogt, "Las lagartijas y las aves guaneras," *BCAG* 15 (September 1939): 346–48; William Vogt, "Informe sobre las aves guaneras por el ornitólogo americano Señor William Vogt," *BCAG* 18 (March 1942): 346–48. See Also William Vogt, "Informe sobre las aves ... Vogt," *BCAG* 18 (March 1942): 3–132.

⁵⁷ See the extensive correspondence on William Vogt's visits to Mexico and Chile and between Vogt and Enrique Ávila in Vogt papers, box 1:1–4; Vogt, *Más guano blanco: Posibles recursos de la costa desértica chilena* (Santiago de Chile: Sociedad Chilena de Fertilizantes, 1945); interview by the author with Basilia Díaz viuda de Ávila and Ingrid Ávila Díaz, Lima, Peru, 13 June 2001; Enrique Ávila, "Ética en marcha," *BCAG* 30 (May 1954): 22–23—a personal interpretation of Leopold's celebrated land ethic that was distributed to hundreds of Peruvian farmers and scientists.

⁵⁸ William Vogt, *People! Challenge to Survival* (New York: Sloane Associates, 1960), 124–25; Vogt, *Road to Survival* (New York: William Sloane, 1948), 110, 155, 186, 221.

⁵⁹ I have found no evidence that these projects were linked in any way—except by the original 1840s "guano rush." See P. B. Best, R. J. M. Crawford, and R. P. Van Der Elst, "Top Predators in Southern Africa's Marine Ecosystems," in *A Century of Marine Science in South Africa*, ed. A. I. L. Payne and J. R. E. Lutjeharms, *Transactions of the Royal Society of South Africa* 52 (1997): 188–91; Lance Van Sittert, University of Cape Town, personal communication.

⁶⁰ *MCAG* 38 (1947): i-ii, v-vi; *MCAG* 39 (1948): vii; *MCAG* 40 (1949): v-vi; *MCAG* 44 (1953): iv; *MCAG* 45 (1954): v; *MCAG* 46 (1955): vi; *MCAG* 47 (1956): vi, xvii; *MCAG* 48 (1957): vi; *MCAG* 49 (1958): xvii-xviii; *MCAG* 52 (1961): xi; Robert Cushman Murphy, *El guano y la pesca de anchoveta: Informe oficial al Supremo Gobierno* (Lima: Compañía Administradora del Guano, July 1954), 23–24; Robert Cushman Murphy, "Peru Profits from Sea Fowl," *National Geographic Magazine*, March 1959, 401, 404–5, 408–9; Martin Rodewald, "Beiträge zur Klimaschwankung im Meere: 10. Beitrag: Die Anomalie der Wassertemperatur und der Zirkulation im Nordpazifischen Ozean und an der Küste Perus im Jahre 1955," *Deutschen Hydrographischen Zeitschrift* 11 (1958): 78–82.

⁶¹ "Anexos: Guano explotado ... durante los años 1909–1962," *MCAG* 54 (1963); UNESCO, Comisión Económica para América Latina [CEPAL], *El uso de fertilizantes en América Latina* (10 October 1966), Doc. E/CN.12/760, pp. 6, 8, 14–15, 94; "Anexos: Detalle de la distribución y venta del guano," *MCAG* 48 (1957); "Anexos: Guano rico—ventas menores," *MCAG* 48 (1957); *Boletín del Comité Nacional de Protección a la Naturaleza* (Lima) 1 (1944), 20 (1970); Murphy, "Peru Profits from Sea Fowl"; and Tovar, Guillén, and Nakama, "Monthly Population," 213–14. For a measure of CAG's marine science apparatus, see *Boletín científico de la Compañía Administradora del Guano* (Lima) 1–2 (1953–1955).

⁶² On the emergence of Peru's fishmeal industry and its ties to the industrial production of livestock, see Baltazar Caravedo Molinari, *Estado, pesca, y burguesía: Teoría y realidad* (Lima: Centro de Proyección Cristiana, 1979); David Carson Edmonds, "Reasons Underlying Development of the Peruvian Fishing Industry in the Post World War II Period," (PhD diss., American University, 1971); and William Boyd, "Making Meat: Science, Technology, and the Industrialization of American Poultry Production," *Technology and Culture* 42 (2001): 631–64.

⁶³ Luis Gamarra Dulanto, "Ensayo sobre la zoonomía de las aves guaneras," *Boletín científico de la Compañía Administradora del Guano* (Lima) 2 (1955): 113, 117; *MCAG* 45 (1954): viii, 5–6, 7–9, 11; Murphy, *El guano y la pesca de anchoveta*, esp. 9–10, 38; Sociedad Nacional de Pesquería, *La anchoveta y la harina de pescado* (Lima, 1954); and *MCAG* 48 (1957): 25–26.

⁶⁴ Tovar, Guillén, and Nakama, "Monthly Population"; Johannes Wille, "Biological Control of Certain Cotton Insects and the Application of New Organic Insecticides in Peru," *Journal of Economic Entomology* 44 (1951): 13–18; *MCAG* 50 (1959), x, anexos; Rómulo Jordán to Luis Massa Giuffrè, "Informe sobre experimentos con garrapaticidas," 15 April 1960, Archivo de la Compañía Administradora del Guano, Estación de Biología Marina, Isla Don Martín, Peru.

⁶⁵ *MCAG* 50 (1959), 14–17; Thorp and Bertram, *Peru, 1890–1977*, 278–79; Geoffrey Bertram, "Peru, 1930–60," in *Cambridge History of Latin America*, ed. Bethell, 8: 420–22, 436–47; Arturo Salazar Larraín, introduction to *Pedro G. Beltrán: Pensamiento y acción (selección de textos)* (Lima: Instituto de Economía de Libre Mercado, 1994), 7–21; and Thyrele Robertson, *The Peruvian Fertilizer Industry, Present Situation and Future Prospects*, Iowa-Peru Program, Economic Study No. 4 (Lima: Iowa Universities Mission to Peru, 1968), 14–17, 21–27, 35, 77–78.

⁶⁶ Carlos Contreras and Marcos Cueto, *Historia del Perú contemporáneo: Desde las luchas por la Independencia hasta el presente*, 2nd ed. (Lima: Instituto de Estudios Peruanos, 2000), 296–99; CEPAL, La oferta de fertilizantes en América Latina (3 November 1966), Doc. E/CN.12/761, pp. 102–110; CEPAL, *El uso de fertilizantes en América Latina*, 3–5, 9095; "Créase la Corporación Nacional de Fertilizantes: Decreto Ley No. 14502," *Boletín de la Corporación Nacional de Fertilizantes* [hereafter, *BCONAFER*] 1 (July 1963): 3–4; *Memoria del Directorio de la*

Corporación Nacional de Fertilizantes 2 (1965): 9–14; "La tragedia de la abundancia," *Pesca*, October 1960, 5–8; "Una realidad: Harina para consumo humano," *Pesca*, August 1961, 13–17, 19–21; "El tabú de nuestro tiempo," *Pesca*, October 1962, 26–30; "Hambre en el mundo," *Pesca*, October 1962, 22–23; "Hambre en el Perú," *Pesca*, October 1962, 24; "Nunca hubo 40 millones de aves," *Pesca*, March 1964, 39–43; "Guerra a la desnutrición," *Pesca* September 1964, 14–20; Enrique del Solar, Manuel Elguera, and Edgardo Llosa, "Informe de la comisión nombrada para estudiar el plan tentativo presentado por el Consejo de Investigaciones Hidrobiológicas y presentar recomendaciones al Directorio de la SNP" (Lima, 23 April 1964), University of California, Institute of Marine Resources, Records, Office of the Director (AC 3), Scripps Institution of Oceanography Library, University of California, San Diego, La Jolla, Calif., [hereafter, UC-IMR], group 3, fol. 174; and IMARPE, "El IMARPE y sus principales investigaciones científicas hasta 1965," *Informe Especial* (La Punta, Callao) 5 (March 1966).

⁶⁷ Rómulo Jordán and Humberto Fuentes, "Las poblaciones de aves guaneras y su situación actual," *Inf.Inst.Mar Perú* 10 (1966): 9, 29; Prince Philip to Felipe Benavides, 5 April 1966, Biblioteca Municipal, Pueblo Libre, Lima, Peru, special exhibition [27 April 2001]; "Coalición contra olores," *Pesca*, February 1961, 22; "Una decisión desatinada," *Pesca*, March 1961, 8–9; "Olores: Solución a la vista," *Pesca*, November 1961, 15–17, 20–21, 23–25; and "Callao: Primer Puerto pesquero del mundo," *Pesca*, January-February 1962, 14.

⁶⁸ "El Niño' y las aves," *Pesca* September 1965, 10–13; "Medidas recomendadas al Supremo Gobierno en relacion con las aves guaneras: Informe presentado por la Sub-Comisión 1: Decreto Supremo No. 67 de 12 de noviembre de 1965," *BCONAFER* 4 (January-April 1966): 94–108; Peru, Comisión de Estudio sobre las Aves Guaneras, *Informe singular de la Sociedad Nacional de Pesquería, integrante de la comisión nombrada por Decreto Supremo no. 67 de 12 de noviembre de 1965* (Lima, July 1966); "Declaraciones de Cubas," *Pesca*, September 1966, 21–23.

⁶⁹ Milner B. Schaefer, "Dynamics of the Fishery for the Anchoveta *Engraulis ringens*, off Peru," *Boletín del Instituto del Mar del Perú* 1 (June 1967): 189–304, quotes on 291–92; IMARPE, "La pesquería de la anchoveta," *Inf.Inst.Mar Perú* 1 (1965); and IMARPE, "Efectos de la pesca en el stock de anchoveta," *Inf.Inst.Mar Perú* 7 (1965). See also the extensive correspondence between Schaefer and Peruvian officials on these issues in UC-IMR, group 4; and Tim D. Smith, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855–1955* (Cambridge: Cambridge University Press, 1994), 249–66.

⁷⁰ Compare to Ramachandra Guha, *Environmentalism: A Global History* (New York: Longman, 2000), 63–68.

⁷¹ Richard P. Horowitz, *Hog Ties: Pigs, Manure, and Mortality in American Culture* (New York: St. Martin's Press, 1998).

⁷² On Peru's Revolutionary Government of the Armed Forces, see Alfred Stepan, *The State and Society: Peru in Comparative Perspective* (Princeton: Princeton University Press, 1978). On the collapse of Peru's fishing industry in 1972–1973, see C. P. Idyll, "The Anchovy Crisis," *Scientific American* (June 1973): 22–29.

⁷³ Guha, *Environmentalism*, chs. 5–6; *Boletín del Comité Nacional de Protección a la Naturaleza* 20 (1970); Wolfgang Sachs, "Environment and Development: The Story of a Dangerous Liaison," *The Ecologist* 21 (1991): 252–57; and Miller and Edwards, eds., *Changing the Atmosphere*.

⁷⁴ To find out more about PROABONOS (est. 1997) and view a gallery of historic photographs, see <http://www.proabonos.gob.pe/>. On marine ecotourism, see Marcia Bonta, "A Peruvian Safari," *Americas* (March-April 1986): 16–23.