

Guano and the Blue Revolution

Your prophecies on Mexican agriculture at the end of the next 100 years have produced quite a national commotion. “Guano,” my dear Doctor, “guano” is the word.

– Carlos Benítez to William Vogt (1946)

Perhaps we should “lose” guano.

– Milner “Benny” Schaefer (1966)

Guano and the Green Revolution

A politically explosive food crisis struck Mexico in 1943. Food prices were already spiraling upward because of World War II. Official policy exacerbated this situation by encouraging the planting of cotton and oilseed instead of grain at the behest of the United States to help the hemispheric alliance against the Axis. A strong La Niña event lasting from July 1942 to mid-1943 brought widespread drought and sharply reduced crop yields in regions such as Sonora dependent on winter and spring rains. This followed directly on the heels of an extreme El Niño event, which contributed to poor summer rainfall in south-central Mexico. This conjuncture of factors placed enormous stress on the Mexican food supply. Many millers had to shut down for lack of grain. Bread and tortilla lines became commonplace. Yucatan, which experienced one of its worst droughts of the past 500 years, suffered a near-famine. Food riots broke out in Mexico City in May 1943. Women’s groups and the state labor union threatened much larger demonstrations if President Manuel Ávila Camacho’s government did not act forcefully to reduce the cost of living. In response, the State Food Agency dramatically increased the marketing of subsidized food to urban consumers, and tried to arrange for massive grain imports from the United States and Argentina. Wartime disruptions to transportation limited these efforts, however. A good harvest in 1944 alleviated the situation somewhat, but La Niña and

drought conditions returned in 1945, sending food prices even higher. The U.S. ambassador to Mexico begged his superiors to send more grain or risk “revolution and the red flag” taking over the country.¹ Mexican officials had good reason to be fearful. In northeastern India, damp conditions during the 1942 dry season provided ideal conditions for the spread of brown spot fungus (*Cochliobous miyabeanus*), which devastated the year’s main rice crop and fueled a famine that killed over three million people. Similar disasters in northern Vietnam and north-central China helped communist insurgents lay down roots. All of these subsistence crises – including the Banaba famine described in Chapter 7 – were connected together by large-scale anomalies in the Indo-Pacific climate system and Asian monsoon, not just the winds of war.²

William Vogt stepped directly into the middle of this situation in May 1943. He spent several days in Mexico on his way back from an organizing tour in South America, and was profoundly affected by the unrest he witnessed. Both Mexican and U.S. Embassy officials listened carefully to his descriptions of the revival of Peru’s guano industry. In response, Ávila Camacho issued a decree on 10 July 1943 “taking into account the experience of the Republic of Peru” that created Guanos y Fertilizantes de México (Guanomex). This parastatal company received full control over all bird islands and guano extraction on the Pacific coast from the U.S. border to Acapulco.³

The history of Mexico’s relationship with guano is almost as old as Peru’s. During the colonial era, indigenous farmers in the vicinity of cities eagerly sought urban night soil and animal manures to produce *tlalauiac* – soil enriched with dung. Those from Xochimilco added bat guano from the caves of Ixtapalapa to their *chinampas*. Ancient farmers probably did, as well. During the nineteenth century, Mexico had a modest guano export industry. In 1854, the famous caudillo Antonio López de Santa Anna issued decrees that prohibited the export of guano by foreigners, banned the hunting of guano birds with firearms, and commissioned a series of expeditions

¹ CEI; quoted in Enrique Ochoa, *Feeding Mexico: The Political Uses of Food since 1910* (Wilmington, DE, 2000), ch. 4; Perkins, *Geopolitics and the Green Revolution*, 125–30; Richard Seager et al., “Mexican Drought: An Observational Modeling and Tree Ring Study of Variability and Climate Change,” *Atmósfera* 22 (2009): 1–31; Blanca Mendoza, “Frequency and Duration of Historical Droughts from the 16th to the 19th Centuries in the Mexican Maya Lands, Yucatan Peninsula,” *Climatic Change* 83 (2007): 151–68.

² Mark Tauger, “Entitlement, Shortage and the 1943 Bengal Famine: Another Look,” *Journal of Peasant Studies* 31 (2003): 45–72; Bin Wang et al., “Interannual Variability of the Asian Summer Monsoon: Contrasts between the Indian and the Western North Pacific-East Asian Monsoons,” *Journal of Climate* 14 (2001): 4073–90; contra Sugata Bose, “Starvation amidst Plenty: The Making of Famine in Bengal, Honan and Tonkin, 1942–45,” *Modern Asian Studies* 24 (1990): 699–727.

³ Decree quoted in Jesús Gracia Fadrique, ed., *Estado y Fertilizantes, 1760–1985* (Mexico City, 1988), 174–77; Vogt to Leopold, 5 July 1943, UWDC-ALA.

to determine the extent of Mexico's guano deposits. This marked the beginning of a sixty-year battle to prevent interlopers from stealing this valuable fertilizer without paying the Mexican state for the privilege. Most of this conflict centered on bird islands off the Yucatan coast such as Isla Cancún, which in those days was known for its colonies of pelicans and magnificent frigatebirds (*Fregata magnificens*) instead of flocks of sunburned tourists. Guano mining off the coast of Baja California began soon after, following on the heels of hunters who devastated the region's nursery for gray whales (*Eschrichtius robustus*). Extraction in this region centered on Rasa Island, a low basaltic platform that harbored enormous colonies of elegant terns (*Sterna elegans*) and Heermann's gulls (*Larus heermanni*); its landscape is now littered with thousands of stone cairns left behind by guano workers. Indigenous Seri from the region often accepted temporary employment as guano miners in return for trade goods, but a large number of Yaqui worked forcibly on the islands as punishment for resisting white colonization of their lands. Most guano from the Gulf of California ended up in Germany or the new agricultural empires of California. Modest quantities of Mexican and Peruvian guano, Chilean nitrates, and locally produced bone and blood meal made it into Mexican soils during the early twentieth century. Circa 1940, however, Mexican farmers applied concentrated fertilizers to only 3 percent of the country's ten million cultivated hectares, at a rate of less than 45,000 tons per year, half of which was imported.⁴

In 1944, Guanomex began extracting guano in the Gulf of California from colonies of brown and blue-footed boobies, and along the Pacific coast of Baja California from colonies of brown pelican and Brandt's cormorant (*Phalacrocorax penicillatus*). Guanomex ignored the colony on Isla Rasa, which had been nearly destroyed by decades of egg collecting to serve the Sonora mining industry. These efforts only produced a paltry thousand tons of nitrogenous guano a year. In response, the director general of Guanomex, Dr. Carlos Benítez, began promoting the idea that Mexican guano production could be increased by more than 200 times by transplanting Peruvian guano birds to the arid Baja coast. Geographers had long contended that the California and Peru Current environments are mirror images of one another, and Benítez hoped that the gregarious guanay and piquero would

⁴ Charles Gibson, *The Aztecs under Spanish Rule: A History of the Indians of the Valley of Mexico, 1519–1810* (Stanford, CA, 1976), 300, 306–7, 558 n. 121; Felipe Buenrostro, *Historia del Segundo Congreso Constitucional de la República Mexicana* (Mexico City, 1875), 2:430–35; Cayo Arenas y otras islas guaneras de los mares de Campeche y Yucatán (Mexico City, 1895), 20–28; Gabriel Aarón Macías Zapata, “El ombligo de los hatos: Payo Obispo y su hinterland forestal,” in *El vacío imaginario: Geopolítica de la ocupación territorial en el Caribe oriental mexicano* (Mexico City, 2004), 125–28; Thomas Bowen, *Unknown Island: Seri Indians, Europeans, and San Estéban Island in the Gulf of California* (Albuquerque, NM, 2000), 122–38; Gracia, ed., *Estado y fertilizantes*, 24, 32–42, 115–20, 124–25, 147–48.

“know better what to do” with offshore shoals of California sardine and anchovy.⁵ This fit with conservation orthodoxy of the time, which advocated the transplant of alien organisms such as kudzu, eucalyptus, cane toads, and Nile perch as an environmental improvement strategy – often with catastrophic consequences.⁶

Peruvian experts soon got involved. In 1944, Compañía Administradora del Guano agronomist Luis Gamarra traveled to Mexico to examine the situation and became an enthusiastic promoter of Benítez’s scheme, but CAG’s general manager Francisco Ballén refused to give a single egg to Mexico at a time when Peru’s guano bird population was at a two-decade low. Benítez dismissed him as “un loco de la casa” and asked Vogt to approach Chilean authorities to arrange the import of guanays. Ballén’s retirement in July 1945 gave the transplantation project a new lease on life. Under pressure from top governmental officials in both countries, CAG and Guanomex drew up a contract to airlift 200,000 eggs and 50,000 live birds a year for twenty-nine years to Mexico. The eggs would be used to trick Mexican birds to raise changelings. Vogt and Gamarra both returned to Baja California late in 1945 to evaluate this new plan with biologist Bibiano Osorio Tafall (1902–90), a prominent political exile from fascist Spain who had been hired by Guanomex to do basic marine research. Osorio Tafall’s studies of marine productivity firmly convinced him that the project to increase guano production was doomed to failure – even if the transplantation succeeded – because upwelling in the region turned out to be much weaker and far more dispersed than off the Peruvian coast. Osorio Tafall kept these views under wraps, however, because he did not want to endanger his job, and instead depended on Vogt and Robert Cushman Murphy to communicate these opinions to his superiors. Vogt offered to wager Benítez “a hundred to one odds that any attempts to establish the guanay on the west coast of Mexico will be a failure.”⁷

These behaviors reveal a major shortcoming of the technocratic ideal. The livelihoods of many experts depend on producing recommendations that advance the narrow political and ideological goals of their employers.

⁵ Gracia, ed., *Estado y fertilizantes*, 177–78; Hutchinson, “Biogeochemistry of Vertebrate Excretion,” 122–32; Johnsgard, *Cormorants, Darters, and Pelicans*, 172–79, 201–8, 387–97; Steve Howell and Sophie Webb, *A Guide to the Birds of Mexico and Northern Central America* (New York, 1995), 123–24, 128–29, 292–93, 305–6.

⁶ Doughty, *The Eucalyptus; Cane Toads: An Unnatural History*, dir. Mark Lewis (1987); Tijs Goldschmidt, *Darwin’s Dreampond: Drama in Lake Victoria* (Cambridge, MA, 1996).

⁷ Benítez to Vogt, 20 Mar. 1944, 4 July 1945, 12 Jan. 1946; Vogt to Benítez, 4 Apr. 1944, 18 Feb. 1946; Vogt to José Colom, 28 Mar. 1945; Osorio to Vogt, 26 May 1945; Ávila to Vogt, 12 Dec. 1945, 2 Apr. 1946, 6 June 1946, 2 July 1946; Vogt to Ávila, 28 Dec. 1945, 26 Sept. 1947, DPL-VP 1/1–3; MCAG 36 (1945): 47–48; MCAG 36 (1946): xi; Rómulo Lanatta, *Informe sobre la Compañía Administradora del Guano* (Lima, 1948), 37–39; Mary Carmel Finley, “The Tragedy of Enclosure: Fish, Fisheries Science, and U.S. Foreign Policy, 1920–1960,” (Ph.D. diss., University of California, San Diego, 2007), 159–62.

To have an effect, forceful criticism often has to come from outside an organization or country. As a consequence, boosters of the Mexican transplantation scheme found it easy to use nationalist posturing to undermine the opinion of foreign scientists. José Carlos Arenas traveled all the way to Peru to promote his extravagant plan to buy US\$600,000 worth of boats, tractors, and bulldozers to collect the wealth of excrement that Peru's guano birds would eventually provide to Mexico.⁸ He boldly dismissed Vogt as "a sentimentalist nature lover who wants to confuse Latin American conservationists for the sole purpose of saving" the sagging California sardine industry. CAG eventually decided to err on the side of caution and close down the project. Osorio Tafall lost his job at Guanomex as a consequence but, with Vogt's assistance, soon acquired a far more prominent position as head of the United Nations Food and Agriculture Organization's (FAO) Latin American office in Santiago de Chile and later served as director of the UN's program of technical assistance to developing countries, where he was an outspoken proponent of fishery development to increase the food supply of the Third World.⁹

To survive, Guanomex had to adopt a dramatically different approach to increasing Mexico's food supply. Ávila Camacho's handpicked successor, Miguel Alemán, made the increase of agricultural production a centerpiece of his 1946 presidential campaign. After his election, he raised the Irrigation Department to cabinet-level status, and initiated a major program to build dams, canals, and farm-to-market roads – to the enormous benefit of Mexico's state-run concrete and petroleum industries. Fertilizer manufacture also occupied a major place in this industrialization program. In 1947, with the aid of a Boston engineering firm, Guanomex opened a fertilizer plant in San Luis Potosí capable of producing seventy-five tons of superphosphate a day using rock imported by railroad from Florida. Guanomex also opened a small bone meal plant in Mexico City and commissioned designs for the country's first ammonia synthesis plant. The U.S.-based engineering firm Chemico won the bid with its innovative design to synthesize ammonium sulfate using high-sulfur natural gas brought to the Valley of Mexico by a new pipeline from Poza Rica, Veracruz. As an added bonus, this process also produced sulfuric acid that could be used for superphosphate production. This industrial facility at Cuautitlán instantaneously increased Mexico's nitrogen-producing capacity by seven times when it opened in 1951. This was the first ammonia-producing plant of any kind in Latin America and

⁸ Equal to US\$6 million in 2007.

⁹ Ávila to Vogt, 12 Dec. 1945, 30 Apr. 1946; Vogt to Ávila, 28 Dec. 1945; Vogt to Osorio, 14 Jan. 1946, DPL-VP 1/1, 3–4; MCAG 38 (1947): xv; Ávila to Mary Sears, [1958], WHOI-SP; Osorio, "El destino marítimo de México," *Revista de economía* (Mexico City) 10 (Aug. 1947); Finley, "Tragedy of Enclosure," 426; Francisco Giral, *Ciencia española en el exilio* (1939–1989) (Barcelona, 1994), 162–65.

TABLE 9.1. *Fertilizer Consumption and Crop Productivity in Mexico, 1950–82*

	1950	1967	1982	% change 1950–82
Cultivated area (million Ha)	10.9	15.3	22.5	207
Fertilized area (million Ha)	0.5	4.0	12.9	2,554
Total area fertilized (%)	4.6	26.2	57.2	—
Nitrogen consumed (thousand mt)	8.5	295.0	1,160.0	13,691
Phosphate consumed (thousand mt)	3.4	101.5	473.4	14,056
Potassium consumed (thousand mt)	0	16.6	118.2	—
Total NPK consumed (thousand mt)	11.8	413.1	1,751.9	14,792
Application rate (kg/Ha)	23.5	103.1	136.0	579
Maize productivity (kg/Ha)	721	1,130	1,779	247
Wheat productivity (kg/Ha)	911	2,727	4,409	484
Bean productivity (kg/Ha)	259	508	638	246
Cotton productivity (kg/Ha)	342	747	895	262
Sugar cane productivity (kg/Ha)	51,300	65,600	67,700	132

mt, metric tons.

Source: Gracia, ed., *Estado y fertilizantes*, 47–66.

provided an influential model for transferring the technology of nitrogen production to Colombia, Peru, and other Third World countries.¹⁰

Fueled by Mexico's rich hydrocarbon resources, large international development loans, and government investments in agricultural education and extension services, Mexican fertilizer production increased by leaps and bounds over the next three decades. By the late 1970s, when Guanomex belatedly changed its name to Fertilizantes Mexicanos (Fertimex), this mammoth state-owned corporation had bought out virtually all of its Mexican competitors, employed close to 10,000 workers, and begun construction of a vast chemical complex in Michoacán capable of producing 1.7 million tons of fertilizer a year. Mexican fertilizer consumption also increased spectacularly (table 9.1). As in Peru, large, highly capitalized cotton, wheat, and sugar cane growers led the way in embracing manufactured fertilizers, but more than half of maize growers and a quarter of bean growers also adopted input-intensive forms of cultivation by the late 1970s. All of these crops experienced major increases in yields. This was especially true of new

¹⁰ Gracia, ed., *Estado y fertilizantes*, 179–83, 262; Hewitt, *Modernización de la agricultura*, 83–88; U.K. Agency for International Development, Mission to Colombia, *Report on Examination of Assistance for Development of the Fertilizer Industry in Colombia* (1967).

varieties of wheat developed by Rockefeller Foundation plant breeders in Mexico, which were then exported to India, Colombia, and other hungry nations around the world. These high-yielding varieties would have been useless without massive nutrient inputs. Such levels of crop productivity made it possible for Mexico to transform itself from a grain importer to one of the world's major food exporters. Agronomists played a foundational role as architects of these transformations, which came to be known as "the Mexican Miracle" – one of the great success stories of the Green Revolution in global crop production after World War II. Vogt's prediction of Malthusian disaster for Mexico, it would seem, turned out to be wrong.¹¹

Before shortcomings of these policies began to emerge, developmentalists all over the world came to view the growth of industries that served agricultural development as indispensable to handling the world's rapidly growing and urbanizing human population in the Third World. The world's policy makers did not ignore the Malthusian warnings of Vogt and Fairfield Osborn. As Mexico's case illustrates, they actually took to heart their apocalyptic predictions – and did their utmost to pave a different road to survival using industrial technologies. It is critical to recognize that *human-centered ecological concerns* relating overpopulation, resource degradation, poverty and hunger, political instability, communist insurgency, and war profoundly influenced the formation of public policy on food, fertilizer, meat, and fish production during the three decades that followed World War II. This was not an "age of ecological innocence" as some environmental historians have claimed.¹² A form of ecological thinking inspired some of the signature international programs of the era. Moreover, the ideological consensus advocating industrialization and development as the answer to the Third World's woes transcended the political dividing lines of the Cold War.

Chapters 7 and 8 explained why population growth, living standards, soil fertility, and food production became so central to these concerns and showed how technocrats acquired so much influence over these activities. This chapter examines how these same issues drove the spectacular growth of fertilizer manufacture, industrial fishing, and meat production in Mexico, Peru, and beyond after 1940. During this period, Mexico exemplified the cornucopian possibilities of the Green Revolution, and inspired Peruvian

¹¹ Gracia, ed., *Estado y fertilizantes*, 42–78, 209, 277–78; Perkins, *Geopolitics and the Green Revolution*, ch. 5; Ochoa, *Feeding Mexico*, 125–26, 138; Hewitt, *Modernización de la agricultura*, pt. 1; Joseph Cotter, *Troubled Harvest: Agronomy and Revolution in Mexico, 1880–2002* (Westport, CT, 2003), ch. 4–5.

¹² Guha, *Environmentalism: A Global History*, pt. 3; Perkins, *Geopolitics and the Green Revolution*, 119–24, 130.

officials to use similar means to increase fertilizer production. In similar fashion, Peru came to exemplify the possibilities and pitfalls of a Blue Revolution in marine fish production and aquaculture. Even though the term is used infrequently, the Blue Revolution was just as important as the Green Revolution in transforming humanity's extraction of nutrition from land and sea during the late twentieth century.¹³ Like Mexico's Green Revolution, Peru's Blue Revolution grew directly out of the guano industry and its dedication to the technocratic ideal. By some measures, Peru's Blue Revolution was an even more spectacular success. In two decades, industrialized fish production grew from nothing to a point where Peru became the largest fish-producing nation on earth. Dozens of countries tried to follow this oceanic path toward development. Once again, the Pacific World was the epicenter of these innovations.

The Geopolitics of the Blue Revolution

The Blue Revolution had its beginning in two circumstances: (1) the Peruvian guano industry's drive to extend its technocratic authority over Peru's marine ecosystem and (2) the international, interethnic competition for Pacific resources that sparked World War II. As we learned in Chapters 5 and 6, the Peruvian state had long sought expert assistance in developing a mechanized fishing industry. In 1928, in the wake of a destructive El Niño, President Leguía authorized CAG to hire a foreign scientist to investigate "the most rational and scientific form of exploitation" of fish along the Peruvian coast. It hired Erwin Hirsch-Schweigger (1888–1965), who from 1923 to 1937 was Fishereidirektor for Altona, the most important port of entry for fish into Greater Hamburg and points inland. This sort of exchange was quite common during the 1920s, when a number of German institutions reached out to Latin America, "the last free continent" open to Germany under the strictures of the Versailles Treaty. The Fischereidirektor for Hamburg made similar investigations for Chile and the Bank of Egypt.¹⁴ Schweigger spent seven months in Peru in 1929–30 touring the Pacific coast and Lake Titicaca. He strongly recommended the creation of a government fishing company similar to CAG that would direct scientific research, diffuse

¹³ Connor Bailey, "The Blue Revolution: The Impact of Technological Innovation on Third-World Fisheries," *Rural Sociologist* 5 (1985): 259–66; James Coull, "Will a Blue Revolution Follow the Green Revolution?: The Modern Upsurge of Aquaculture," *Area* 25 (1993): 350–57.

¹⁴ BCAG 5 (July 1929): 366–67; *Der Fischerbote* 15 (1923): 18; 20 (1928): 195–96, 345–47, 363–65; 22 (1930): 119–22, 377–83; 29 (1937): 367–72; *Diccionario histórico y biográfico*, s.v. "Schweigger, Erwin"; Stefan Rinke, "Die letzte freie Kontinent": *Deutsche Lateinamerikapolitik im Zeichen transnationaler Beziehungen, 1918–1933* (Stuttgart, 1996).

new fishing techniques, market refrigerated fish, and perhaps manufacture fishmeal for use as fertilizer or livestock feed, but the Great Crash prevented Peru from acting on his suggestions. Gildemeister & Co.'s parallel attempt to establish a motorized fishing fleet to producing cheap food for its agroindustrial labor force met a more violent end. Native Peruvian fishermen from Puerto Chicama torched Gildemeister's Italian-operated fleet to eliminate this threat to their livelihoods, as part of a wave of xenophobic violence against immigrant fishermen along the Peruvian coast.¹⁵ Schweigger was of Jewish descent and convinced CAG to give him a permanent job to help him escape from Nazi Germany in 1937. Like Mexico with Osorio Tafall, Peru was thus able to take advantage of the global diaspora of technical experts away from countries under authoritarian rule during this era.¹⁶

The worsening crisis in Peruvian guano production caused by the Tangüis cotton boom and 1939–41 El Niño led CAG officials to consider a new way to harvest nutrients from the sea. Schweigger had long been a proponent of creating a German fishmeal industry, and at his suggestion, CAG hatched a plan to directly exploit the guano birds' main food source, the anchoveta. In 1940, CAG sent agronomist Luis Gamarra on an expedition to the United States to study the harvest and processing of menhaden and sardines for use as livestock feed. Gamarra's enthusiastic report described how CAG could quickly set up a manufacturing complex capable of producing 50,000 metric tons of fishmeal per year. This new industry promised to satisfy "rising demand for nitrogen fertilizer by the nation's agriculture" while producing "a product with excellent market openings" for export abroad. CAG's conservation technocrats are the ones who gave birth to the original plan to replace Peru's guano birds with a fishmeal industry, based on the ecological argument that Peru could dramatically increase its production from the sea by directly exploiting a lower level of the Humboldt Current food chain.¹⁷

Enthusiasm for Gamarra's plan quickly spread. In 1940, Manuel Prado's government issued Law 9140 for the Promotion of Industry, a landmark in the history of Peru's industrialization. This decree included a clause that established an expert commission charged with mapping out the future of the fishing industry in Peru. In parallel, Prado asked the U.S. government to send a mission of fishing experts to the country. In January 1941, three members of the U.S. Fish and Wildlife Service arrived in Peru, two with experience

¹⁵ MCAG 22 (1931): 268–80; 15 (Aug. 1939): 315–16; *Pesca* Jan.–Feb. 1962: 13–14; Baltazar Caravedo Molinari, *Estado, pesca y burguesía: Teoría y realidad* (Lima, 1979), 20–21.

¹⁶ Ávila to Sears, 12 Mar. 1952, 30 Apr. 1952, 12 Aug. 1953, 19 Mar. 1955, 14 June 1957, 14 July 1959; Betulfo Vaca to Sears, 19 May 1952, WHOI-SP; BCONAFER 3 (Aug. 1965): 3–4; Giral, *Ciencia española en el exilio*; Mitchell Ash and Alfons Sollner, eds., *Forced Migration and Scientific Change: Emigré German-Speaking Scientists and Scholars after 1933* (Cambridge and New York, 1996).

¹⁷ *Der Fischerbote* 26 (1934): 194–95; 27 (1935): 52–56; BCAG 16 (Nov. 1940): 340–79.

developing the fishing industries of U.S. colonies in the Caribbean. This mission, like many of this era, was intended to advance the United States' Good Neighbor Policy and strengthen international ties with a potential wartime ally.¹⁸

These experts came to reverse a paradoxical situation. In 1940, Peru produced a total catch of 11,863 metric tons worth S/.2,373,000, but exported a paltry 208 tons of fish products. Even though Peru had one of the richest marine ecosystems in the world, it imported around a thousand tons of fish products a year, mostly canned fish from Japan. Like many developmental experts of this era, the North American Fishery Mission framed this situation as a technological problem to be solved by the introduction of new craft and techniques. To this end, its staff sailed to Peru in the *Pacific Queen*, an eighty-foot purse-seine trawler (*bolichera*) newly built in Tacoma, Washington, and used it to train Peruvians in the use of fishing gear and the taking of scientific measurements.¹⁹ At the conclusion of the mission, CAG borrowed S/.650,000 from the Banco Industrial del Perú to purchase the *Pacific Queen*, a full purse-seine net outfit, a complete terrestrial fishmeal plant with lighter fleet, and a mechanized storage and transport facility from California. To help ensure the success of this venture, Prado gave CAG the sole right to "anchoveta fishing on a grand scale" in Peru's territorial waters, but the wartime interruption of regular shipping, rapid inflation, and problems raising capital prevented CAG from completing this fishmeal complex, even after spending three times the amount of the original loan. CAG eventually sold this unfinished plant to Italian-Peruvian entrepreneur Marcos Ghio in 1955 at a steep discount and turned over the *Pacific Queen* to its own scientists for use in oceanographic research. CAG never produced a gram of fishmeal.²⁰

The North American Fishery Mission to Peru was a tremendous success in other respects, however. Industrialized fishing for bonito (*Sarda chilensis*) took off in the wake of its visit as suppliers of vitamin-rich fish livers and life-giving protein to a war-torn world. Hostilities cut off the international supply of preserved fish and fish liver oils from two of the world's largest

¹⁸ MCAG 30 (1939): 61–62; MCAG 33 (1942): ix, 67–68; Norman Jarvis, *The Fisheries of Puerto Rico*, Bureau of Fisheries Investigational Report [BFIR] no. 13 (1932); Reginald Fiedler and Jarvis, *Fisheries of the Virgin Islands of the United States*, BFIR no. 14 (1932); Thorp and Bertram, *Peru, 1890–1977*, 186–87, 190–95, 205–6; David Green, *The Containment of Latin America: A History of the Myths and Realities of the Good Neighbor Policy* (Chicago, 1971), vii–x, 294–95.

¹⁹ Equal to US\$4.5 million in 2007. Fiedler, Jarvis, and Milton Lobell, *The Fisheries and the Fishery Industries of Peru with Recommendations for Their Expansion and Development* (Washington, DC, 1942), 2–3, 8–9, 14, 16, 36, 191–23, 333–38, 351; Caravedo, *Estado, pesca y burguesía*, 25–26.

²⁰ Equal to US\$1.1 million in 2007. MCAG 33 (1942): ix, 69–72; 37 (1946): ix; 42 (1951): vii; 46 (1955): 16; Lanatta, *Informe*, 90–91.

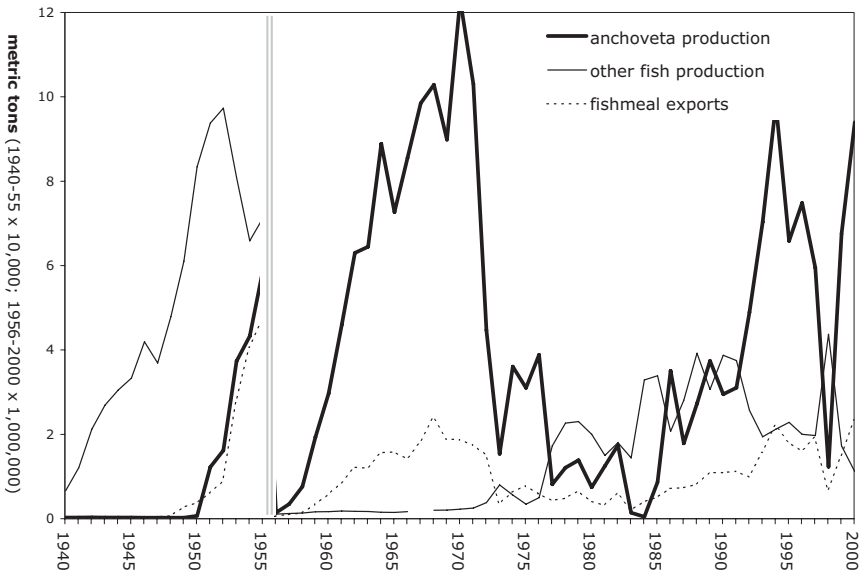


FIGURE 9.1. Fish and fishmeal production in Peru, 1940–2000. *Source:* Cushman, “Lords of Guano,” table 7, app. 9.

producers, Japan and Norway. In 1942, Peruvian entrepreneurs exported 320 tons of fish livers cut from bonito and sharks. At first, they wastefully discarded everything else, but the U.S. War Foods Administration soon began buying barrel-salted fish and canned bonito produced by three plants financed by the Prado family bank. Prado’s government helped out by negotiating the removal of all duties and tariffs on U.S. imports and by creating an official agency to provide technical assistance. By the end of the war, there were twelve companies operating twenty-three canneries in Peru with installed equipment valued at S/.15 million, despite logistical difficulties importing gear.²¹ In 1946, the peak of wartime production, Peruvian companies extracted 41,722 metric tons of fish from the Pacific, 10,560 tons of which were exported (fig. 9.1). Wilbur-Ellis Peruana, a subsidiary of the San Francisco fishing company, played a crucial role in these developments as a provider of technical expertise, canning equipment and supplies, and served as the main distributor of Peruvian bonito on the U.S. market.²² Meanwhile, the North American Fishery Mission to Peru served as a model for technical missions sent elsewhere to increase the supply of fish to Allied forces.

²¹ Equal to US\$22 million in 2007.

²² Cushman, “The Guano Lords,” table 7; Harold Cary, “Report #7,” 11 Sept 1953, SIO-AC40, 28/1, p. 4; *Pesca Mar.* 1961: 11–13; Sept. 1962: 58; Caravedo, *Estado, pesca y burguesía*, 23–27; Thorp and Bertram, *Peru, 1890–1977*, 180–81; Belaúnde, *La legislación pesquera*, 229.

Two participants headed straight from Peru to the West Indies, “to further economic and social cooperation among the nations of the Western Hemisphere,” then to the South Pacific, Iceland, England, and Chile. The success of these missions helped convince ideologues in many parts of the world to view the ocean as the next frontier for industrial-scale food production.²³

Peru’s Blue Revolution came into being thanks to the combined efforts of government officials, local entrepreneurs, and foreign experts working in fortuitous historical circumstances. Like many Third World development programs, this new industry almost went belly up when these conditions turned unfavorable. Peru’s market for salted fish and fish livers dried up almost overnight when Japan, Norway, and other war-torn countries resumed fish production with the help of economic aid and trading preferences provided by the United States. Many Peruvians felt deeply betrayed that Japan was able to regain its status as the world’s largest fish-producing nation in this way. Peru also had new competitors to deal with. Fiji, American Samoa, Tahiti, and Australia developed tuna canning industries of their own during the 1940s, whereas the U.S. tuna industry received a massive transfer of decommissioned military craft, most of which were sent to fishing grounds off Latin America. Spending by the Marshall Plan and Point Four programs explicitly supported the expansion of industrial fishing in China, West Germany, and South Africa to increase the world’s supply of high-protein food. In 1949, under pressure from the California tuna industry, the U.S. Food and Drug Administration made Peru’s situation even more difficult by banning the sale of bonito as “tuna” based on the harmless but off-putting tendency for the flesh of Peruvian fish that season to turn green when canned and the dubious scientific claim that bonito belonged to an entirely different classification of fish. The Peruvian fishing industry figured out how to remedy the former problem, but these taxonomic regulations remained in force, leading Peruvians to accuse the United States of practicing fish “racism” against the darker-toned flesh of the bonito. Wilbur-Ellis saved the day, temporarily, with discount supermarket pricing and an expensive advertising campaign favoring Peruvian bonito. By 1953, however, thanks to overproduction by competitors in the northern and central Pacific, almost all of Peru’s 50 canneries and 630 motorized fishing craft were operating far below capacity. Many were completely inactive. The collapse of U.S. tuna prices in 1954 and increased protective tariffs in 1956 made the situation even worse. Meanwhile, Peru’s fleet of vessels for

²³ Fiedler, Lobell, and Clarence Lucas, *The Fisheries and Fishery Resources of the Caribbean* (Washington, DC, 1947); *American Men of Science* (New York, 1949), s.v. “Fiedler, R(eginald) H(obson)”; Milner Schaefer, “Confidential: Report on Assistance to the Government of Chile,” draft manuscript, n.d. [1961], SIO-MC2, 3/212; Osorio Tafall, “El destino marítimo de México,” *Revista de economía* (Mexico City) 10 (Aug. 1947); W. H. Chapman, “The Wealth of the Oceans,” *Scientific Monthly* 65 (1947): 192–97.

producing frozen yellowfin tuna (*Neothunnus macropterus*) and swordfish (*Xiphias gladius*) was barely utilized, thanks to an abrupt but lasting change in their geographic distribution far away from the Peruvian coast during the El Niño of 1953. These problems caused social dislocations. Since the war, competition from mechanized boats and the prospect of well-paid work in the fishing industry had convinced thousands of male artisanal fishermen to leave their traditional craft and become industrial proletarians. Thousands of women had also taken jobs in canning factories, which followed the California industry's practice of only hiring female shop-floor workers. Both groups now faced massive unemployment. The Peruvian government tried to mitigate these problems and diversify the industry by building modern market terminals in Callao and Lima and by waging publicity campaigns to encourage domestic fish consumption. These efforts failed to create a robust Peruvian market for marine fish. These woes – underutilization of equipment capacity, dependence on imported technology and expertise, flaccid local markets, and underemployment – typified those that have faced industrialization programs in the Third World, and they have continued to dog the Peruvian fishing industry for the rest of its history.²⁴

Peruvians had other reasons to feel anxious about the future of fishing off their coast. The end of the war enabled long-distance fishing fleets to again set their sights on this productive region. As early as 1936, Van Camp Sea Food of California had approached the Peruvian government for permission to enter Peru's three-mile territorial sea so its tuna clippers could catch anchoveta for use as bait. Peru was not the only country that feared foreign depredation of its offshore resources. During the late 1930s, Japanese interest in pelagic salmon off the coast of Alaska greatly increased geopolitical tensions with the United States in the far northern Pacific. Meanwhile, the use of offshore factory ships to process fishmeal severely undermined attempts by the State of California to regulate sardine production, to the point that this lucrative fishery was on the verge of collapse. In 1945, under intense pressure from U.S. oil and fishing companies, President Harry Truman unilaterally issued two proclamations claiming the "natural resources of the subsoil and sea bed of the continental shelf beneath the high seas but contiguous to the coasts as appertaining to the United States" and the right to establish fishery "conservation zones . . . subject to the regulation and control of the United States" beyond the traditional territorial sea. In places, these proclamations extended the country's territorial claims hundreds of miles offshore. The United States was not the first country to do

²⁴ Cushman, "The Guano Lords," table 7; interview with Aurora Chirinos de Vildoso, 11 June 2001; *Pesca y caza* 2 (1951): 3–16; Antonio Tarnawiecki, "A Survey of the Development of Oceanic Fisheries in Peru," *Peruvian Yearbook & Northern Peru Supplement of the Peruvian Times* Jan. 1955: 129–30, 135; *Pesca* Feb. 1961: 14–16; Mar. 1961: 12–15; Mar. 1967: 15–21; Finley, "The Tragedy of Enclosure," 236, 257–67, 278–85, 355–60, 417–18, 422–23, 426–27, 434, 535, 540.

this. In 1942, the United Kingdom and Venezuela signed a treaty asserting Venezuela's territorial rights to undersea petroleum resources several miles off its coast. Argentina and Mexico followed with similar proclamations in 1944 and 1945. However, such claims made little sense for the narrow continental shelf lining the Pacific coast of South America, which did not encompass the region's rich upwelling zones. In 1947, Peru followed Chile in declaring an Exclusive Economic Zone (EEZ) extending 200 nautical miles (370.4 kilometers) from its coast. In 1948–49, Iceland, Costa Rica, and several Arab states claimed similar territorial rights to petroleum and fishery resources far off their shorelines. In 1952, Ecuador declared its own 200-mile EEZ and joined Peru and Chile in signing the Santiago Declaration on the Maritime Zone. This agreement stated that “the geological and biological factors that condition the existence, conservation, and development of . . . maritime flora and fauna” had made “the ancient extension of the territorial sea . . . insufficient for the conservation, development, and exploitation of these riches to which adjacent coastal countries have a right.” This codified what became known in international law as the “biome” or ecosystem defense of the 200-mile EEZ, a neologism introduced to these debates by CAG scientist Enrique Ávila at the First Latin American Congress on Marine Biology held in Chile in 1949, based on his work with William Vogt and Aldo Leopold. These competing declarations threw the international Law of the Sea governing territorial rights to the ocean into utter chaos. The Truman administration eventually withdrew its Fisheries Proclamation but could not close this Pandora's box.²⁵

What started as a battle of words focused on the marine resources of the Pacific Basin soon degenerated into a battle of blows. In 1947, the Peruvian navy seized its first U.S. tuna clipper for violating Peru's EEZ in search for anchoveta to bait its hooks. In 1954, Aristotle Onassis sent out a whaling fleet from Hamburg explicitly to challenge Peru's 200-mile limit. After a lengthy game of cat and mouse, the Peruvian navy triumphantly seized five ships, the remains of 3,000 whales, and forced Onassis to pay a US\$3 million fine.²⁶ Buoyed by this defeat of a Goliath of international shipping, the Peruvian navy began to seize and fine U.S. tuna trawlers for violating the zone. Active hostilities came to a halt in 1956 when the American Tunaboat Association negotiated a licensing agreement with Peru that reinvested the

²⁵ Quoted in Eduardo Ferrero Costa, “Evolución del derecho del mar,” *Revista del Instituto de Estudios Histórico-Marítimos del Perú* (Lima) 3 (1980): 79; Ávila, “Necesidad de afianzar el respecto de las declaraciones de los estados sobre sus respectivos mares territoriales,” *Revista de Biología Marina* (Valparaíso) 6 (1955): 200–7; Sergio Teitelboim Volosky, *Chile y la soberanía en el mar* (Santiago de Chile, 1965), 55–61, 66–72; David Loring, “The Fisheries Dispute,” in *U.S. Foreign Policy and Peru* (Austin, TX, 1972), 62–67, 72, 86–87, 115–18; S. N. Nandan, “The Exclusive Economic Zone: A Historical Perspective,” in *The Law and the Sea* (Rome, 1987); McEvoy, *The Fisherman's Problem*, 148–49, 192; Finley, “The Tragedy of Enclosure,” 167–183, 200–8, 412, 495–96.

²⁶ Equal to US\$19 million in 2007.

resulting income in scientific research. This agreement eventually collapsed, however, when tuna fishermen switched from bait fishing to drift nets in the early 1960s. From 1947 to 1974, the Pacific Tuna War, as this confrontation came to be known, resulted in the seizure of more than 250 U.S. ships and the payment of over US\$6 million in fines to six Latin America states.²⁷

Global opinion eventually turned in favor of Peru's position toward the territorial sea. In 1982, after years of negotiations, 150 countries signed a 320-article convention enabling any coastal state to declare jurisdiction over ocean resources up to 200 miles off its coast. This massive allocation of property rights – the largest in the history of the planet – profoundly affected the small island nations of the Pacific. Long before it was signed, this agreement began generating licensing income from long-distance tuna fishermen and gave renewed energy to the independence movement in the Gilbert & Ellice Islands Colony, which split into the nations of Tuvalu and Kiribati in 1978–79. Some held out the hope that this would result in the creation of a locally based fishing industry that would serve indigenous consumers. At twenty-six square kilometers, Tuvalu trails just behind Nauru as the fourth smallest independent state on earth, but Kiribati, Tuvalu, and Nauru together possess exclusive economic rights to 4.6 million square kilometers of the Pacific Ocean, about a third of the size of claims by the world's largest maritime empire, the United States.²⁸ Thanks to the efforts of Peru and its neighbors to defend the right of small states to a share of the sea, the guano islands of the Central Pacific now possess new importance as territorial placeholders determining who can exploit the ocean. Once again, the history of the Pacific World was profoundly shaped by events emanating from the coast of South America.

“To Fish or Not to Fish?”

Garrett Hardin's “tragedy of the commons” posits that a natural resource left open to competitive harvesting will tend to be exploited until it is degraded or destroyed, unless some form of “mutual coercion mutually agreed upon” forces the parties involved to utilize the resource in a sustainable way. Economists call this “the fisherman's problem” and have recognized the difficulties of producing a sustainable yield from the ocean since the 1950s. Of course, this is the basic premise that inspired the formation of CAG's monopoly over guano extraction and a host of other state-led conservation programs around the world during the twentieth century. The

²⁷ MCAG 47 (1956): xviii; Loring, “The Fisheries Dispute,” 70–73; Thomas Wolff, *In Pursuit of Tuna: The Expansion of a Fishing Industry and Its International Ramifications* (Tempe, AZ, 1980), 53–54, 96–102, 118.

²⁸ Macdonald, *Cinderellas of Empire*, 177–82, 272–73; Flanders Maritime Institute, VLIZ Maritime Boundaries Database, <http://www.vliz.be/vmcddata/marbound/index.php>.

belief that government jurisdiction is required to prevent the destructive overexploitation of the ocean's fisheries also played an important part in the rhetoric defending extension of the territorial sea. In fact, many advocates of the 1982 Law of the Sea Convention hoped these innovations would place a far greater portion of the ocean under technocratic control.²⁹

The fear that uncontrolled exploitation would eventually destroy Peru's marine resources also pervaded three decades of debate regarding the development of industrialized fishing for anchoveta. In 1936 when Van Camp Sea Food asked for permission to fish for bait, Francisco Ballén enunciated what eventually became the guano industry's party line:

In Peru, the exercise of fishing is intimately tied to the guano industry and the abundance of certain fish, especially the anchoveta. . . . Every method of fishing on a grand scale along the coast would thus be plainly inadvisable, all the more so taking into consideration that it will be impossible to exercise effective control over the fishing methods put into practice. It is also worth taking into consideration . . . that the fish obtained will be exported. The meager duties this firm offers will not compensate in the least for this waste.³⁰

Luis Gamarra used a form of ecological reasoning to try to counter these concerns. As part of his advocacy for the creation of a fishmeal industry, Gamarra performed an incompetent experiment involving cage-fed guanays to determine the biological efficiency of guano production. He concluded that each guano bird consumed 32 kilograms of fish for every kilogram of guano it produced. This compared quite unfavorably to the 4:1 efficiency he claimed for the fishmeal industry. William Vogt pointed out fatal flaws in Gamarra's work and pleaded for caution, citing problems facing the California sardine fishery. "Exploitation of natural resources by man is *almost always a dangerous proceeding*, unless it is done with care and skill," Vogt admonished, "especially since guano is a resource that will exist in perpetuity." Gamarra responded by comparing guano birds to "wild animals and insects that attack crops" and accused Vogt of trying to take money out of the pockets of future Peruvians.³¹ Later feeding experiments showed that guano bird chicks are capable of converting anchoveta to guano at an efficiency as high as 4.46:1, but fishing industry partisans conveniently ignored these findings and continued to cite Gamarra's junk science decades after the fact.³² The ceremonial display of quantitative findings with little

²⁹ Hardin, "Tragedy of the Commons"; McEvoy, *The Fisherman's Problem*, ch. 1; *Our Common Future: Report of the World Commission on Environment and Development* (Oxford, 1987), 272–74, 287 n. 17.

³⁰ MCAG 28 (1937): 183–84.

³¹ Vogt's emphasis; BCAG 17 (Mar. 1941): 103–15; 18 (Mar. 1942): 60–64, 109; Gamarra, "Memorandum," 9 May 1941; Vogt to Ballén, 16 May 1941, DPL-VP 1/4, 3/2.

³² BCCAG 1, no. 2 (1954): 21–49; BCAG 35 (Apr. 1959): 10–22; SNP, *La anchoveta y la harina de pescado* (Lima, 1954), 52–53; *Pesca* Oct. 1960: 13–16; July 1970: 28–29.

substance is disturbingly common when science is used to produce public policy. It is the Achilles heel of technocratic forms of governance.³³

The defenders of the guano birds won the initial debate: CAG received exclusive control over the direct production of fishmeal from anchoveta, but nothing prohibited the manufacture of fishmeal from other sources. In 1945, Peruvian canners began producing fishmeal on a significant scale from spoiled bonito; two years later, they started exporting it. They found a ready market because of an ongoing ecological disaster in the northern Pacific. Overfishing and climate variability caused the fishery for sardines (*Sardinops sagax*) to collapse abruptly in the Pacific Northwest during the late 1940s. The Southern California fishery followed suit in the mid-1950s. Despite multiple interventions by science and government, total production of sardines along the Pacific Coast of North America fell progressively from 614,045 metric tons in 1944–45 to a low of 14,873 in 1953–54, and it never recovered. The huge Japanese fishery for herring off Hokkaido also collapsed in close parallel. Firms like Wilbur-Ellis suddenly had a mountain of surplus industrial machinery on their hands and offered it to enterprising Peruvians at bargain prices. By the end of 1953, at least nine Peruvian canners had installed fishmeal reduction equipment, led by companies with ties to Wilbur-Ellis, but their ability to manufacture fishmeal was strictly limited by levels of canned fish production, which had declining prospects. To bolster the industry's sagging fortunes, the right-wing military government of Manuel Odría (president 1948–56) abolished CAG's monopoly on fishmeal from anchoveta soon after taking power. In 1950 in Chimbote, a Peruvian entrepreneur with close ties to Wilbur-Ellis, Manuel Elguera McParlin, opened Peru's first factory devoted solely to the reduction of fishmeal from anchoveta. He also organized a political advocacy group, the Sociedad Nacional de Pesquería (SNP), to defend the right to freely exploit the ocean's resources. A severe drop in the abundance of bonito and tuna off the Peruvian coast during the moderate El Niño of 1953 led a number of Peruvian canners to abruptly refocus their efforts toward fishmeal production. By the end of that year, there were ten fishmeal plants in Peru devoted solely to the exploitation of anchoveta.³⁴

³³ Markoff and Montecinos, "The Ubiquitous Rise of Economists"; Guillermo O'Donnell, *Modernization and Bureaucratic-Authoritarianism in South American Politics* (Berkeley and Los Angeles, 1979), 79–82, 99, 102–5; Naomi Oreskes and Erik Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (New York, 2010).

³⁴ Mary Sears to Columbus Iselin, 2 Sept. 1953, WHOI-MC9; MCAG 44 (1953), 8–9; Tarnawiecki, "Development of Oceanic Fisheries," 129–31, 135; Roemer, *Fishing for Growth*, 61, 80–83; Caravedo, *Estado, pesca y burguesía*, 35–37; McEvoy, *The Fisherman's Problem*, 146–47; Edward Ueber and Alec MacCall, "The Rise and Fall of the California Sardine Empire," in *Climate Variability, Climate Change, and Fisheries* (Cambridge and New York, 1992); Tokimassa Kobayashi et al., "Long-Term Fluctuation of the Catch of Pacific Herring in Northern Japan," *PICES Scientific Report* no. 15 (2000): 103–6.

These actions inspired another round of intense debate regarding the wisdom of creating a fishing industry that would compete directly with the guano birds. In 1952, Erwin Schweigger and Enrique Ávila submitted a seven-point proposal to the Ministry of Agriculture recommending the prohibition of daytime fishing for anchoveta (to protect the birds) and limitation of the annual catch to 25,000 metric tons (later increased to 100,000 tons). The SNP rejected these arbitrary limits on principle, noting that they lacked any explicit scientific justification. In response, CAG advocated for the creation of an independent board of experts to develop fishing standards that would not threaten the “unstable equilibrium” of Peru’s marine ecosystem. CAG explicitly pointed to the ongoing collapse of the California sardine fishery in support of strict fishing quotas. Scientists from the government’s Dirección de Pesquería y Caza, on the other hand, argued that the guano and anchoveta industries could develop safely in parallel. As a compromise, high-level officials placed limits on the number of construction permits granted to fishmeal plants but refused to set production quotas.³⁵

In an attempt to break this impasse, CAG invited two conservation scientists of “worldwide fame” to study Peru’s marine environment with “disinterest” and “affection for pure science.” CAG explicitly hoped that the opinions of these outsiders would “reach the higher spheres of our Government more forcefully.” Frances Clark (1894–1987) was one of the world’s preeminent authorities on the California sardine and northern anchovy (*Engraulis mordax*). She served as director of the California State Fisheries Laboratory at Terminal Island from 1941–57, which made her the only U.S. woman scientist with a significant policy-making position during this period.³⁶ In 1939, she publicly predicted the immanent collapse of California sardine stocks and recommended strict limits on their harvest at a level not greater than 250,000 metric tons – half the catch at the time. She eventually led a faction of scientists who blamed human harvesting for the dramatic decline of the sardine against those who blamed natural environmental fluctuations. She worked closely with CAG’s scientific team during three survey cruises, which allowed Clark to have a level of access to shipboard research she was totally unused to as a woman in the sexist United States. She drafted a detailed plan for anchoveta research, but to CAG’s chagrin, she cautiously refused to offer explicit recommendations for the regulation of the anchoveta fishery.³⁷

³⁵ Ávila to Sears, 14 Nov. 1952, WHOI-MC9; MCAG 44 (1953): 4–12, 49–51; MCAG 45 (1954): 5–6, 7–9, 11; BCNPN 11, no. 1 (1954): 11–13; Cary, “Report #7,” 11 Sept. 1953, SIO-AC40, 28/1, pp. 8–9; Caravedo, *Estado, pesca, y burguesía*, 35.

³⁶ Carlos Llosa to Clark, 21 July 1953, WHOI-MC9; MCAG 45 (1954): viii; Patricia Stocking Brown, “Early Women Ichthyologists,” *Environmental Biology of Fishes* 41 (1994): 23–24, 28; Rossiter, *Women Scientists in America*, 301.

³⁷ Clark, “Can the Supply of Sardines Be Maintained in California Waters?” *California Fish and Game* 2 (1939): 172–76; Clark, “Biology of the Anchoveta,” 25 June 1954; Clark,

This might have been fatal to CAG's position, if not for adamant support for strict regulation by U.S. ornithologist Robert Cushman Murphy. After a whirlwind survey of the Peruvian and Chilean coasts, Murphy made his report at a widely publicized conference at the University of San Marcos in January 1954. He unambiguously warned against killing "the hen that lays the golden egg" by allowing a large industrialized fishery oriented toward export to threaten the guano birds. He thought guano and fish production were both "equally subject to ecological depressions of irregular incidence," thanks to El Niño, and reasoned that "stable production or populations probably do not exist" in the Peru Current ecosystem. "Wisdom" therefore mandated that Peru place strict limits on industrial fishing until "much more has been learned about the life cycle of anchoveta." Otherwise, "a new 'Saturnalia'" akin to Peru's Guano Age might result, and perhaps lead the Peruvian anchoveta fishery to the same "calamitous" fate as the California sardine, Chesapeake oyster, or extinct passenger pigeon.³⁸

In response, Lima's most prestigious daily newspaper, *El Comercio*, restated its strong support for strict fishing regulations. Peruvian fishing industry executives, on the other hand, quickly rounded up their own "scientific circle" to refute Murphy. Following a strategy similar to the campaign waged by U.S. chemical companies against Murphy and other critics of pesticide use, the SNP boldly sought to discredit Murphy's expertise and objectivity. Because he was an ornithologist, Murphy supposedly "cannot be considered capable to carry out studies and arrive at solutions for problems related to marine fauna and biology." "No serious investigator" would dare present such "incongruous ecological examples." By their calculus, the guano birds were the ones that threatened the ecological "equilibrium" of the ocean: their "indiscriminate multiplication" would inevitably lead to their "overpopulation" and collapse – all the while, snatching anchoveta away from the fishing industry and stealing needed animal protein from the world's exploding population.³⁹ On two separate occasions, an SNP spokesman used the front page of the archconservative Lima daily *La Prensa* to present "the exploitation of guano birds" as "an index of the industrial backwardness of the nation," because it supposedly stood in the way of the development of home-grown chemical fertilizer and fishing industries. Modern Peruvians needed "neither guano birds, nor fishmeal as fertilizer, only the extended and planned protection of the national fishing industry as a productive source of excellent cheap food."⁴⁰

"Program for Anchoveta Investigations," 26 Apr. 1954, SIO-AC6 17/25; McEvoy, *The Fisherman's Problem*, 158–66.

³⁸ Murphy, *El guano y la pesca de anchoveta* (Lima, 1954), 9–10, 14–18, 29–31, 36–39.

³⁹ BCNPN 11, no. 1 (1954): 15–17, 20–21; SNP, *La anchoveta y la harina de pescado*, 1–5, 54–56.

⁴⁰ Pedro Cortázar, "¿Comen más de lo que producen?" *La Prensa* 29 Jan. 1954; Cortázar, "Ni guano, ni harina, sino protección a la pesca," *La Prensa* 21 Mar. 1954.

This increasingly hostile debate had direct political repercussions. CAG's general manager Carlos Llosa was hardly surprised when Odría's government fired him as a scapegoat for the impasse, but this act could not obscure the fact that popular opinion and public officials remained divided on the issue of strict regulation. All parties concerned decided to put the question to a new set of outside experts – powerful testimony to the strength of the technocratic ideal in Peru. CAG already had a foreign consultant in mind that was sure to be acceptable to the fishing industry: fishery biologist Milner “Benny” Schaefer (1912–70). He had collegial relationships with a broad range of marine scientists, government officials, and fish producers within the Pacific Basin, thanks to his efforts at developing a scientific system for managing international tuna fishing under the auspices of the Inter-American Tropical Tuna Commission. Schaefer convened a roundtable meeting that brought together representatives from the various sides in August 1954. His intervention resulted in the formation of a Consejo de Investigaciones Hidrobiológicas to “coordinate and support marine biological studies with a view to the greater utilization and control of natural resources.” This action had an immediate impact by convincing the American Tunaboat Association to begin purchasing licenses so it could work within Peru's Exclusive Economic Zone, on the condition that payments went straight to the Consejo. This brought an end to the Tuna War for the time being, but political red tape within the Consejo hamstrung its scientific work and caused it to produce little of value for shaping policy.⁴¹

While Peruvian marine science got itself organized, CAG's “take it slow” approach governed public policy toward the ocean. Manuel Prado's second government adopted a loose fiscal policy when it took power in 1956 to encourage industrial development and consumer purchases. This had the unintentional result of sparking an abrupt construction boom that rapidly doubled the anchoveta fishery's capacity to more than 100,000 tons. Prado responded by suspending the licensing of new plant construction and plant expansion in December to avoid threatening “the equilibrium of the biological chain” of the Peru Current ecosystem. However, the speculative sale of existing licenses and government corruption severely undermined this attempt to limit the growth of the fishmeal industry.⁴²

⁴¹ Ávila to Sears, 20 Aug. 1953, 19 July, 15 Oct. 1954, WHOI-MC9; Schaefer to Ávila, 2 Aug. 1954, SIO-MC2 17/54; U.S. Fishery Mission to Peru, “Proposal for a Fisheries Research Contract in Peru,” 30 Oct. 1954, SIO-AC6 17/25; “Memorandum,” [1954]; ATA to Guillermo Tirado, 15 Nov. 1954; “Agreement on the Granting of Permits for Exploitation of the Resources of the South Pacific,” TC No. 13424-A, T-36/52/R-V, SIO-AC40, box 60; Warren Wooster, Peru journal, 1957–58; Wooster to Presidente del Consejo, 2 May 1958, Wooster papers; interview with Wooster, 9 Jan. 2005.

⁴² MCAG 48 (1957): 25–26; Belaúnde, *La legislación pesquera en el Perú*, 141; Caravedo, *Estado, pesca, y burguesía*, 47–48, 142–43; Thorp and Bertram, *Peru, 1890–1977*, 245–46.

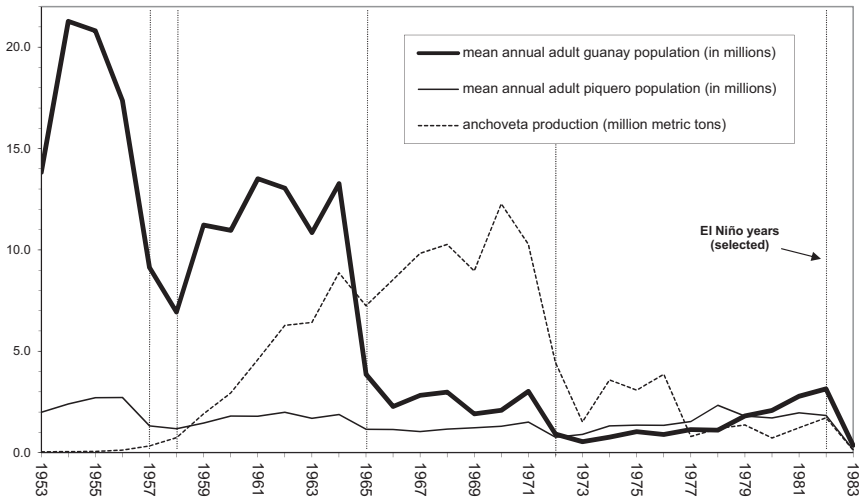


FIGURE 9.2. Anchoveta production and guano bird numbers in Peru, 1953–83. *Source:* Tovar, Guillén, and Nakama, “Monthly Population Size of Three Guano Bird Species.”

Then came the “ecological depression” everyone had dreaded. In 1957–58, a strong El Niño event struck the Pacific Basin. As we learned in [Chapter 6](#), Peru’s guano birds had increased dramatically over the preceding decade, thanks to years of La Niña conditions, strong upwelling, and CAG’s policy of creating new breeding locales. As SNP officials predicted, bird numbers and guano production crashed catastrophically ([fig. 9.2](#)). In response, CAG beseeched Prado’s government to deploy “more energetic methods” to slow down the “frenetic” development of the fishmeal industry. To pacify CAG, the Ministry of Agriculture held a roundtable meeting of experts in September 1957, but little came of it. In the meantime, the construction boom continued, causing Peruvian anchoveta production to almost triple in 1957, then double again in 1958. Two years of declining guano production finally convinced the government to act. In December 1958, Prado issued regulations restricting the time, season, location, and net size of anchoveta fishing, particularly in the vicinity of the guano islands, and prohibited the transfer of fishmeal production licenses from old to new plants. These laws were to remain in place until “biological studies . . . determine the maximum yield possible that will protect the national economy.”⁴³

The fact that the Prado administration acted in this way is testimony to the political importance that the guano industry and conservation principles still possessed, but his government had far more pressing problems to

⁴³ See [fig. 9.1](#); MCAG 49 (1958): vi–vii, 7, 10, 12–14, 18, 21; MCAG 50 (1959): v, 14–17; Belaúnde, *La legislación pesquera en el Perú*, 372–75; Caravedo, *Estado, pesca y burguesía*, 47–48.

deal with. A prolonged drought in the Sierra caused a dangerous shortfall in food production that required Peru to use precious foreign exchange to import food. Sugar cane and cotton growers also experienced poor yields because of a dearth of fertilizer and irrigation water and a self-induced plague of pesticide-resistant insects; what they did produce sold for low prices because of a sharp downturn in the world economy. The Prado administration's loose credit policies also resulted in unexpectedly heavy purchases of imported goods. As a consequence, Peru experienced its worst trade deficit since before the turn of the century. Late in 1957, Prado called out to the International Monetary Fund (IMF) for help. The IMF gave Peru's central bank a substantial line of credit with the understanding that it would impose austerity measures. Prado and his allies balked at these suggestions. If he put the squeeze on wages, salaries, and consumption, he risked losing his political base among Peru's popular classes and stirring up massive urban unrest. If he imposed direct currency exchange controls to stop the outflow of capital, he risked harming the export sector and cutting off foreign investment. Prado's government instead tried to weather the crisis through increased deficit spending, but this only worsened Peru's balance-of-payments situation and plunged the country into deeper recession. In 1959, the Peruvian Congress gave a vote of no-confidence that almost caused Prado's fragile democratic coalition to collapse entirely.⁴⁴

In July 1959, Prado appointed a new breed of technocrat to clean up this mess. Pedro Beltrán (1894–1979) was a product of Peru's new guano age. He was born into one of the most influential families of the Aristocratic Republic and earned an economics degree at the London School of Economics in 1918 but decided to take up cotton growing just as the Tangüis cotton boom was getting underway. Beltrán embraced the role of the progressive farmer: he hired a team of agronomists to manage his Cañete valley plantation, mechanized its cultivation, and was reputedly the first Peruvian to apply arsenical insecticides to his crops using airplanes. Under his tenure, Montalván estate quickly rose among the ranks of CAG's top guano consumers. While engaged in these endeavors, Beltrán emerged as a major spokesman for agroexporters on Peru's far right wing. He was fiercely dedicated to classical free-market principles and an outspoken supporter of the military takeover of 1948. As director of the Banco Central de Reserva under General Odría, he engineered a marked shift toward a monetarist economic policy that brought enormous wealth to Peru's agroexporters. He turned into a vocal critic of Odría's regime, however, when his superiors reversed course and adopted Keynesian prescriptions promoted by the IMF. Beltrán countered by inviting Austrian economist Ludwig von Mises, one of the founding ideologues of neoliberalism, to stand by his side when he

⁴⁴ Thorp and Bertram, *Peru, 1890–1977*, 278–79; Bertram, “Peru, 1930–60,” in *The Cambridge History of Latin America* (Cambridge and New York, 1991), 8:442–47; Portocarrero et al., *Compendio estadístico del Perú*, 40, 42, 168, 170.

stepped down as central banker in 1950. Beltrán continued broadcasting his doctrinaire opinions from his newspaper *La Prensa* – including tireless support for Peru’s fishmeal industrialists – and ended up in prison in 1956 for criticizing Odría’s authoritarian regime. Beltrán was a true forerunner of the neoliberal technocrats of the late twentieth century.⁴⁵

Prado gave Beltrán free reign over Peru’s economic policy. Beltrán proceeded to devalue the sol markedly, raise fuel prices, and establish a series of special tax exemptions for business. He also revoked most of the laws limiting the growth of the fishmeal industry to “stimulate the commercial development of the country on the basis of free enterprise.” These actions brought a sudden end to the debate “to fish or not to fish.” The international economy cooperated with Beltrán’s designs: the recession passed. Planting and production of cotton and sugar cane went up sharply, notwithstanding problems with pests and the fertilizer supply. Anchoveta production and fishmeal export income mushroomed from 737,019 metric tons worth US\$17.9 million in 1958, to 6.2 million tons worth US\$119.8 million in 1962.⁴⁶ In that year, Peru passed Japan as the number one producer of fish by tonnage in the world and immediately became the poster child for the Blue Revolution. This export boom turned into a general economic boom. To some, Beltrán looked like a genius, even though his policies mainly benefited the rich and did nothing to address the rural crisis that fed the growth of vast, unplanned shantytowns in coastal cities. At the end of Prado’s term in 1962, Beltrán tried to use these achievements to springboard to the presidency, but he failed to recognize that much of Peru’s populace had grown to hate his unending rhetoric against land reform, “wage inflation,” and workers that “consume more than they produce.” Beltrán quickly dropped out of the race and political life but left a legacy that doomed Peru’s marine environment to ecological catastrophe.⁴⁷

Chicken from the Sea

The spectacular growth of Peru’s fishmeal industry has often been portrayed as inevitable, once California’s sardine fishery collapsed and the sentimental defenders of the guano birds got out of the way. As fishing industry boosters

⁴⁵ Arturo Salazar Larraín, ed., *Pedro G. Beltrán: Pensamiento y acción* (Lima, 1994), 7–21; Dennis Gilbert, *The Oligarchy and the Old Regime in Peru* (Ithaca, NY, 1977), 342, 352–58; César Hildebrandt, *Cambio de palabras: 26 entrevistas* (Lima, 1981), 96–98; *Diccionario histórico y biográfico*, s.v. “Beltrán Espantoso, Pedro”; *Enciclopedia ilustrada del Perú*, s.v. “Beltrán, Pedro.”

⁴⁶ Equal to US\$105 million and US\$797 million in 2007, respectively.

⁴⁷ Cushman, “The Lords of Guano,” app. 6, 9; *Pesca y caza* 9 (1959): 130–31; MCAG 51 (1960): 25–27; MCAG 54 (1963): 21–24; *Pesca* May–June 1962: 66; Belaúnde, *La legislación pesquera en el Perú*, 144–45; Edmonds, “Reasons Underlying Development of the Peruvian Fishing Industry,” 81–86; Bertram, “Peru, 1930–60,” 8420–22, 436–47; Pike, *The Modern History of Peru*, 273–74, 296–99; Salazar, ed., *Beltrán*, passim.

loved to point out, the world's exploding population was too hungry for protein to let this enormous resource go to waste. These explanations underestimate the continuing influence of conservation principles in Peru, however; they fail to explain how Peru's industry grew to be twenty times larger than the North American industry it replaced; and they simply ignore the final destination of these fish.

A global ecological perspective on history reveals that the Peruvian fish-meal boom was a key constituent of an ongoing revolution in the world's eating patterns. Like the nineteenth-century guano boom, this sudden opening of the Pacific Ocean to outside exploitation did little to increase the world's total food supply. Instead, it enabled an affluent minority of the planet's population to eat higher on the food chain. Peru's Blue Revolution represents an extreme form of neo-ecological imperialism that had the further effect of teaching the world to think that development would allow everyone to eat large quantities of meat and fish.

As we learned in Chapters 7 and 8, one of the main preoccupations of commentators on human population growth focused on the ability of Japan and other nations to attain the steady diet of meat associated with the "American standard of living." William Vogt, for example, privately blamed Peruvians' high death rate, alleged "lack of vigor," inability to concentrate, and "national mournfulness" on a diet too low in protein.⁴⁸ Beliefs of this sort drove agricultural researchers after World War II to give almost as much attention to the development of heavier, faster-growing livestock as they did to high-yielding crops. The growth of the U.S. beef industry and its environmental impacts has received substantial attention from historians, but hog- and chicken-raising actually achieved far more spectacular gains in scale and productivity (table 9.2). The average weight of "young meat-type" broiler chickens in the United States, for example, increased from 1,360 grams in 1945, to 1,720 grams in 1975, to 2,130 grams in 1995. Feed-to-meat conversion efficiencies rose from 26 to 48 to 53 percent and time-to-market maturity dropped from 95 to 56 to 47 days over this same period. In Western Europe and the Soviet Bloc, research instead focused on fast-growing pigs. There are biological reasons why chickens and pigs achieved such spectacular gains: they are capable of converting feed to body tissue with far greater efficiency than cows, sheep, and other ungulates, which evolved to subsist mainly on plant cellulose. Similar to the "miracle crops" of the Green Revolution, these advances in animal production resulted from a package of developments in breeding, nutrition, disease management, enclosure air conditioning, and other forms of environmental control. By many measures, these programs were an amazing success. Since 1961 when comprehensive FAO statistics begin, global meat production has tripled, per capita consumption has nearly doubled, and the international meat trade has grown by more than seven times. In 2007, chickens accounted for 51.1 billion of

⁴⁸ Vogt journal, Sept. 1940, DPL-VP 3/1.

TABLE 9.2. *Global Meat and Fish Production and Consumption, 1961–2000*

	1961	1971	1981	1991	2000
<i>World slaughtered animals (millions of head)</i>					
Beef cattle	173	204	237	258	278
Chickens	6,585	11,405	19,334	28,080	41,377
Pigs	376	595	749	936	1,151
Sheep	331	372	401	473	487
Andean camelids	0.8	0.5	0.4	0.4	0.5
Total (all types ^a)	8,365	13,808	22,426	32,350	47,691
<i>World slaughtered animal production (thousands of metric tons)</i>					
Beef cattle	27,685	38,074	45,940	53,896	56,517
Chickens	7,553	13,643	24,321	37,269	58,187
Pigs	24,743	39,414	52,986	70,908	89,584
Sheep	4,930	5,626	5,860	7,121	7,624
Andean camelids	27	18	15	14	14
Total (all types ^a)	71,177	104,575	139,055	183,836	232,965
<i>Per capita meat consumption (kilocalories/day)</i>					
World	110	136	155	181	210
United States	335	378	389	411	445
European Union ^b	266	346	397	417	427
USSR	189	249	303	362	185 ^c
China	29	87	132	240	402
Japan	26	75	116	149	165
Latin America and Caribbean ^d	177	167	213	216	281
Brazil	112	126	168	235	358
Mexico	148	137	242	199	265
Peru	78	78	71	75	74
Sub-Saharan Africa ^e	67	67	68	65	65
Australia and New Zealand	510	495	461	480	461
Kiribati	149	156	151	107	151
<i>Marine fish production (thousands of metric tons)</i>					
World	28,051	46,425	48,604	66,767	71,103
United States	1,817	1,672	2,039	3,534	3,303
European Union ^b	4,906	6,316	6,093	5,471	5,334
USSR	2,287	6,050	8,049	7,807	3,978 ^c
China	1,560	1,830	2,257	4,719	8,787
Japan	4,848	7,845	8,905	7,202	3,639
Indonesia	473	744	1,199	2,170	3,279
Sri Lanka	57	65	172	188	283
Latin America and Caribbean ^d	6,163	13,258	9,403	15,886	18,122
Chile	70	389	1,389	3,291	5,787
Cuba	18	106	132	128	51
Ecuador	32	92	512	312	591
Mexico	97	260	1,354	1,082	966
Peru	5,209	10,489	2,675	6,807	10,507

	1961	1971	1981	1991	2000
<i>Marine fish production (thousands of metric tons)</i>					
Sub-Saharan Africa ^e	1,555	2,277	1,916	2,048	3,175
Angola	241	318	123	109	228
Ghana	35	190	195	293	371
Australia and New Zealand	69	94	221	479	629
Other Oceania ^f	31	67	126	183	303
<i>Per capita seafood consumption (kilocalories/day)</i>					
World	17	21	23	24	28
United States	20	22	29	30	31
European Union ^b	29	32	32	40	50
USSR	33	47	56	49	27 ^c
China	8	9	8	17	35
Japan	113	159	182	194	178
Indonesia	17	20	25	31	44
Sri Lanka	28	22	30	38	53
Latin America and Caribbean ^d	8	12	16	14	15
Chile	12	15	31	33	22
Cuba	12	27	33	25	24
Ecuador	11	13	24	12	9
Mexico	4	7	24	21	20
Peru	25	21	28	25	37
Sub-Saharan Africa ^e	10	14	17	14	14
Angola	12	19	23	22	22
Ghana	37	74	44	50	64
Australia and New Zealand	19	20	25	29	32
Kiribati	75	93	99	136	132

^a Includes asses, beef cattle, buffalo, camels, other camelids (alpaca, llama, guanaco, vicuña), chickens, ducks, goats, geese, horses, mules, pigeons and other birds, pigs, rabbits and other rodents, sheep, and turkeys. Production by weight also includes game meat, snails, and other miscellanea.

^b Includes member states as of 2000.

^c Russian Federation and former Soviet Republics.

^d No data for Anguilla, Aruba, British Virgin Islands, Cayman Is., Falkland Is., French Guiana, Guadeloupe, Martinique, Monserrat, Puerto Rico, St. Pierre and Miquelon, Turks and Caicos Islands, U.S. Virgin Islands.

^e No data for Equatorial Guinea, Réunion, St. Helena, Somalia.

^f Includes American Samoa, Cook Island, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, Nauru, New Caldeonia, Niue, Norfolk Island, Northern Mariana Island, Palau, Papua New Guinea, Pitcairn Island, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Fortuna Islands. FAO data for Oceania is too incomplete to estimate consumption levels.

Source: FAO Statistical Databases.

the 58.6 billion animals killed for meat, and 28.2 percent of the 269 million tons of meat produced worldwide. The pork industry did even better, producing 99 million tons of meat from the slaughter of 1.3 billion pigs. When we look at the globe as a whole, chicken and pork, not beef, are the true modern meats.⁴⁹

As table 9.2 shows, consumers in the First World and Soviet Bloc were the first to benefit from these trends. Consumers in other regions eventually benefited as well – China more than anyone. Since the “Three Bad Years” of 1959–61 when starvation killed an estimated 30 million people, meat consumption by the world’s most populous nation has increased by a power of ten. In terms of food calories, the Chinese now consumes almost as much meat as the First World and twice that of fish-eating Japan. Thanks to such dense sources of energy, the average citizen in these high-consuming countries now takes in more than 2,900 kilocalories per day – making these the fattest human societies in the history of the earth. These national accounts also reveal some troubling regional inequalities. Peruvians, sub-Saharan Africans, and the I-Kiribati, per capita, consume nearly the same amounts of meat as they did a half-century ago – and it is no coincidence that poor citizens of these regions have replaced the Chinese as mass-media icons of hunger and misery.⁵⁰

The widespread use of concentrated fertilizers and nutritionally balanced, high-protein feeds was fundamental to these developments. As we learned in Chapter 4, massive imports of island phosphate used to fertilize pasture made it possible for Australia and New Zealand to consume meat in great quantities. Meat production today in many other parts of the world is based on a throughput system formed from an ecological triumvirate of nitrogen fertilizer manufacture, maize and soybean cultivation, and pen-raising of livestock. All three steps require enormous amounts of fossil fuel energy and provide a nasty, brutish, and short existence for most of the animals involved. In a stark reversal of the guano age, pen-raising of livestock now produces concentrations of excrement so great that animal manure has become an environmental hazard in many locales, rather than a boon to soil fertility.⁵¹

⁴⁹ FAO statistical databases; William Boyd, “Making Meat: Science, Technology, and the Industrialization of American Poultry Production,” *Technology and Culture* 42 (2001): 631–64; János Kovács, *Egyetemes és Magyar agrárfejlődés* (Budapest, 2005), ch. 5, §14–17; Ted Steinberg, *Down to Earth: Nature’s Role in American History* (New York, 2008), ch. 12; Orville Schell, *Modern Meat* (New York, 1984).

⁵⁰ B. M. Popkin, “The Nutrition Transition and Obesity in the Developing World,” *Journal of Nutrition* 131 (2001): 871S–73S; Greg Critser, *Fat Land: How Americans Became the Fattest People in the World* (New York, 2003).

⁵¹ Smil, *Enriching the Earth*, ch. 7–10; David Kirby, *Animal Factory: The Looming Threat of Industrial Pig, Dairy, and Poultry Farms to Humans and the Environment* (New York, 2010).

This modern meat-focused agroecosystem did not spring into existence fully formed. The industrial production of fishmeal from Peru's coastal waters for use as high-protein feed gave an important boost to its creation. From 1948 to 1958, the global fishmeal industry doubled in size, and the market for imported fishmeal multiplied by over six times, from 111,000 metric tons worth US\$15.3 million to 693,000 metric tons worth US\$103.4 million.⁵² From there, the Peruvian boom almost single-handedly caused global production of fishmeal to jump to two million tons a year in 1960. This new supply temporarily glutted the international market for high-protein feeds and caused prices to fall to the point where far more live-stock farmers could afford them. On the consumption side, West German swine farmers and U.S. chicken raisers bought the largest quantities of Peruvian fishmeal, followed by the United Kingdom and Netherlands. During the 1960s, U.S. purchasers of supermarket broilers and buckets of fast-food fried chicken were literally consuming chicken from the sea.⁵³

These economic changes had geopolitical repercussions. Fishmeal-based chicken production proved so profitable for U.S. farmers that they were able to undersell their counterparts in Western Europe. This sparked the so-called Chicken War over meat exports to the European Economic Community, which convinced its member nations to aggressively promote industrial animal production and to close ranks around the idea of forming a federal union. Meanwhile, the Soviet Union tried to keep up with the West by deploying a fleet of massive factory ships to harvest seafood and fishmeal, which proved to be frighteningly efficient at vacuuming up everything in reach of their nets, hooks, and harpoons on the high seas – often just beyond the reach of the territorial sea of Western nations. As [table 9.2](#) shows, per capita meat consumption in the USSR and what became the EU both increased by more than 30 percent during the 1960s, and Soviet marine fish production almost tripled as a result of these policies.⁵⁴

Fishmeal production on this scale required fundamental changes to humanity's relationship with the marine environment, especially off the coast of Peru. Industrial anchoveta fishing began with the purse-seine trawler, a technology that was transferred directly from U.S. salmon and sardine fisheries by the North American Fishery Mission. At first, Peruvian anchoveta fishermen simply motored along the coast close to port and searched for surface schools by sight. They depended heavily on watching guano birds to locate schools of fish – just like the ancient kin of Don Pedro Guaneque.

⁵² Equal to US\$112 million and US\$604 million in 2007, respectively.

⁵³ FAO statistical databases; *Pesca* June 1961: 15, 23–35; Edmonds, "Reasons Underlying Development," 111–12, 116–17, 120, 123–25, 131, 138–40, 142–43.

⁵⁴ Ross Talbot, *The Chicken War: An International Trade Conflict between the United States and the European Economic Community, 1961–64* (Ames, IO, 1978); C. P. Idyll, *The Sea against Hunger: Harvesting the Ocean to Feed a Hungry World* (New York, 1970), 42–45, 114–21.

Fish were easiest to find between October and February, when the breeding of guano birds also reached its peak. A secondary fishing season lasted from April to June when the year's new crop of fry (*peladilla*) became large enough to catch, even though they had not yet reached sexual maturity.⁵⁵

The widespread adoption of several new technologies by the Peruvian anchoveta fishery utterly transformed the industry's capacity to locate and capture fish. In 1954, directional echo-locaters (SONAR) originally developed by northern militaries to hunt submarines went on sale in Peru. But these imported, high-tech instruments were expensive and required substantial technical skill and experience to operate. Their growing popularity in the mid-1960s dramatically increased the depth and distance at which fishing boats could locate subsurface schools of fish and eventually made the guano birds superfluous to the search. As a result, birds came to be considered pests, rather than friends, of the fisherman.⁵⁶ In 1955, nylon nets first became available in Peru. The development of this revolutionary synthetic fiber by the Du Pont Corporation was itself a derivative of large-scale production of nitrogen compounds using the Haber-Bosch process. Engineers in several countries adapted it for use in fishing nets after World War II. The most successful of these was the Momoi Fishing Net Manufacturing Co. of Ako, Japan, which eventually conquered the Peruvian market. Synthetic nets were technically superior to Peruvian-produced cotton nets in almost every way. By 1959, the use of cotton nets in Peru had virtually disappeared – to the direct detriment of Peruvian cotton growers. Nylon nets were also amenable for use with high-powered cranks, which made it possible to manipulate enormous drift nets that reached much deeper than the guano birds could effectively dive. Besides sweeping the sea of fish, these nets also snared and drowned vast numbers of guanays, which swim underwater to catch their prey.⁵⁷ This only begins to account for the dazzling array of goods that the Peruvian fishing industry imported from around the world and that local industries sprang up to produce. These included waterproof clothing from Norway, manila fiber rope from the Philippines, foam floats and rubber hose from the United States, steel cable and metal sheeting from the United Kingdom, and entire fishmeal plants from Denmark. Boat construction factories sprouted up by the dozens in Callao during the height of the fishmeal boom and, at their peak, built 1,200 new craft in a single

⁵⁵ *Bol.Inst.Mar* 1, no. 2 (1965): 89–90, 98–102; *Inf.Inst.Mar* 6 (1965): 8–16, 25.

⁵⁶ *Bol.Inst.Mar* 1, no. 2 (1965): 97; *Pesca* Apr.–May 1961: 16–19, Aug. 1961: 8–9, June 1963: 45, 64; Jan. 1966: 28–29.

⁵⁷ *Pesca* Oct. 1961: 44–50, Sept. 1964: 23–25, July 1965: 27, Apr. 1966: 37, Apr. 1968: 30, Jan. 1968: 8–12, Apr. 1968: 30; David Hounshell, "Du Pont and the Management of Large-Scale Development," in *Big Science: The Growth of Large-Scale Research* (Stanford, CA, 1992).

year. One enterprising Peruvian developed a jute sack factory using new fiber supplies from the Peruvian Amazon.⁵⁸

Finding and catching anchoveta was only half the story. The conversion of wet, perishable fish into dry, inert fishmeal also required the direct transfer of reduction plant technology from the United States and Scandinavia. At the peak of the industry, these plants produced 1 ton of fishmeal for every 5.4 tons of anchoveta unloaded at the plant – far below the efficiencies Gamarra claimed. Unlike guano production, these plants were not environmentally benign. They required large amounts of energy produced by smoke-belching, on-site diesel generators or Peru's overstressed electrical network. Fishing boats also used diesel engines, usually Caterpillar-brand, and the industry as a whole used prodigious quantities of fuel oil. From 1960 to 1964, the industry burned 217 million liters costing S/.628 million to do something the guano birds did for free. This fuel was mainly produced from Peruvian wells by the International Petroleum Company, a subsidiary of Standard Oil operating in far northern Peru.⁵⁹

Most of Peru's early fishmeal factories sprouted up either in Callao or Chimbote, although dozens of other coastal settlements eventually came to possess their own smelly plants. Chimbote was situated to become the world's largest fish-producing city thanks to massive environmental alterations accomplished by a government development project started during World War II. This program drained 225 square kilometers of coastal wetland in the vicinity, connected the town to the Pan-American Highway and Huaraz railway, constructed a high dam and 50-Mw hydroelectric facility on the Santa River, and built a state-owned steel mill. Immigrants from rural areas poured into Chimbote looking for work, causing it to grow from a malaria-ridden 4,000 in 1940 to more than 60,000 in 1960.⁶⁰

The rapid pace of the fishmeal industry's development eventually inspired an environmentalist backlash in Peru's largest city. Fishmeal plants were notorious for emitting vile fumes. The Lima-Callao area, like much of the Peruvian coast, is also subject to temperature inversions, when a cap of warm upper air sits on top of a cool marine layer and prevents the dispersal of pollutants. When the region's prevailing southeastern winds failed to blow, the smell of rotten fish could permeate everything – including districts populated by the country's elite. In 1960–61, municipal health inspectors in the Lima-Callao area began organizing a grassroots movement against fishmeal odor, based on the specious claim that plant emissions were responsible for epidemic rates of allergies, skin and eye problems, and asthma. High concentrations of noxious gases produced by fishmeal plant equipment and

⁵⁸ *Pesca* Nov. 1960: 28, 30; Nov. 1961: 57; Apr. 1963: 27–32; Jan. 1967: 22.

⁵⁹ Equal to US\$127 million in 2007; *Pesca* Jan–Feb. 1962: 7; Apr. 1964: 15; June 1965: 48.

⁶⁰ *Pesca* June 1961: 87–97; *Peru: Obra de gobierno del Presidente de la República Dr. Manuel Prado, 1939–1945* (Buenos Aires, 1945), 43–48.

decomposing fish were indeed responsible for causing worker injuries and occasional deaths, but defenders of the fishing industry rightfully pointed out that the rapid proliferation of buses, trucks, private automobiles, and other smokestack industries during the 1950s was a far more likely cause for these urban health problems. Peoples' noses told them differently, however, and the fishing industry soon found itself on the run. Municipal officials in Callao acted first to mandate the installation of deodorizing equipment. Peru's central government followed suit in March 1961 but dragged its feet about enforcement while a commission sought assistance from experts who had installed similar equipment at fishmeal factories in smog-prone Los Angeles. Unfortunately, the least costly abatement option required abundant fresh water. The main concentration of factories along Avenida Argentina in Callao would have to use expensive gas incineration, which required burning an additional 100 to 200 liters of fuel oil for every ton of fishmeal produced. The inspector of hygiene in Callao brought this controversy to a head during the austral spring of 1961 when he made a series of surprise visits to fishmeal plants and handed out hefty fines for various workplace violations. President Prado responded by issuing a decree in August 1961 giving Callao producers four months to install deodorizers. To prevent escalating the controversy and causing it to spread to other cities, the SNP gave in and promised to discipline noncompliant companies, as long as the government helped out with short-term loans. This caused the air pollution issue to die-down, but provided a strong motivation for producers to build factories elsewhere, thereby exporting the problem to less-regulated locales along the coast.⁶¹

The fishing industry also generated gigantic quantities of water pollution, but no comparable movement emerged to clean up Peru's coastal waters. Every time a fishing boat unloaded its catch, it dumped hundreds of liters of bilge water into the sea containing 10 percent anchoveta blood and other biological matter. Scandinavian engineers who had been compelled by environmental laws to clean up the North Sea fishmeal industry determined that Peru lost a quarter of its potential production by dumping unprocessed wastewater into the sea. The "gospel of efficiency" mandated action, but importing the stainless-steel equipment needed to process stickwater was prohibitively expensive. This machinery also required new recirculating driers, additional energy expenditures, and abundant supplies of freshwater. In 1968, the Peruvian Congress extended tax breaks to importers of stickwater processors, but only a third of fishmeal factories took advantage. Even with these improvements, an estimated 4,200 tons of untreated stickwater entered the ocean *every hour* during peak season in 1970. The Bays of Chimbote,

⁶¹ Pesca Dec. 1960: 18–19; Feb. 1961: 22; Mar. 1961: 8–9; Apr.–May 1961: 24–25; June 1961: 108; July 1961: 48; Sept. 1961: 47; Nov. 1961: 15–27; Mar.–Apr. 1962: 15–23; July–Aug. 1962: 71–72; Feb. 1968: 10–14; Apr. 1970: 16–21.

Supe, and Tambo de Mora were the worst affected and became eutrophied dead zones. The Bay of Callao was also negatively affected – and had the additional challenge of dealing with industrial effluent and untreated sewage from a city of three million people. Artisanal fishermen living in these polluted ports had to travel far away to locate fish; many simply abandoned the trade entirely. Peru's guano birds, of course, produced none of these problems.⁶²

At this stage, however, most observers tended to overlook these signs of trouble and emphasize the industry's spectacular growth. A few lucky investors acquired enormous fortunes. Luis Banchero (1929–72) was the golden boy of the fishmeal boom. He began his working life in a small liquor store run by his Italian-Peruvian parents in the southern city of Tacna. In 1955, he bought a down-and-out bonito cannery in Chimbote and used assistance from Wilbur-Ellis to purchase a purse-seine outfit and convert the factory to fishmeal production. From there, he rode the fishmeal boom to the very top. By age thirty-one, he was one of the richest men in South America and the second largest fishmeal producer in the world, after the U.S. Gulf Coast's "king of menhaden" Harvey Smith.⁶³ This industry also proved attractive to a number of agroexporters, including Gildemeister & Co., W. R. Grace & Co., and the Pardo, Lavalle, Klinge, and Graña families – a circumstance that further undermined support for the guano industry. In 1961, Rafael Graña sold his cotton plantation to buy into the fishing business. Within two years, he owned the second largest fishmeal company in Peru and soon expanded into ship construction. He went bankrupt one year later when the fishmeal industry experienced its first major downturn causing Chancay, a fishing city he helped build overnight, to become the first coastal boomtown to go bust when the anchoveta mysteriously disappeared from its vicinity. As time passed, more and more large multinational corporations such as Ralston-Purina, Heinz, Cargill, General Mills, and Gold Kist became noticeable in the upper echelons of the Peruvian fishmeal industry.⁶⁴

Dozens of other Third World countries set out to imitate these accomplishments. Benny Schaefer was one of the most vocal proponents of the idea that the world could dramatically increase its supply of high-protein

⁶² *Pesca* Jan. 1961: 19–27; Jan.–Feb. 1962: 13–25; Jan.–Feb. 1963: 71; Oct. 1963: 64–67; Jan. 1967: 28–30; June 1968: 28; Mar. 1971: 22; Apr. 1971: 10–16; Luis Arriaga, "Contaminación en el Océano Pacífico Suroriental (Ecuador-Perú-Chile)," *Revista de la Comisión Permanente del Pacífico Sur* 5 (1976): 3–62.

⁶³ *Pesca* Oct. 1960: 22–26; Mar. 1963: 33–34; June 1966: 57; Edmonds, "Reasons Underlying Development of the Peruvian Fishing Industry," 62; *Diccionario histórico y biográfico*, s.v. "Banchero Rossi, Luis."

⁶⁴ *Pesca* Sept. 1961: 39; May–June 1962: 66; Sept. 1963: 15–22; Mar. 1963: 44; Apr. 1963: 51; Sept. 1964: 32; July 1965: 12–17; Jan. 1966: 24; Feb. 1966: 12–16; Apr. 1966: 35; May 1967: 20–25, 36; July 1967: 36, 38; Aug. 1967: 27–28; May 1969: 27; Feb. 1970: 20–21; Jan. 1971: 29.

food if it followed Peru's example. He believed it would be easy to double, and perhaps quadruple, production from the seas to 200 million tons of fish a year if the rest of the world followed Peru's example and focused on lower levels of the marine food chain. This estimate was widely cited during the debate surrounding Paul Ehrlich's *Population Bomb* (1968).⁶⁵ The FAO and UN Development Programme provided one major source of support for these endeavors. They were the initial builders of Ecuador's fishing industry, for example. The United States, Scandinavia, and Japan also funded fishery missions to the Third World, both to extend the influence of their experts and to stimulate exports of industrial equipment. Cold War geopolitics provided the main motivation for Soviet sponsorship of fishery industrialization programs in Ghana and Cuba. Third World governments also provided their own impetus to these programs. The Chilean Development Corporation (Corfo) nationalized fishmeal the industry just south of the Peruvian border after disruptions caused by the El Niño of 1965–66 and later used Soviet help to begin developing a trawling fleet; the industry grew even faster after Augusto Pinochet's technocrats turned it over to private investors in the late 1970s. Lucrative funding from the Mexican state during the 1970s built thousands of artisanal vessels and a long-distance tuna fleet almost as large as the United States. These craft have littered the shores of the Gulf of California with discarded shark remains, however, and harvest most of the small fish that once fed Mexico's guano birds. In recent years, China has rapidly emerged as one of the earth's great fish-producing powers. In 2007, it produced an incredible 41.1 million metric tons of fish and other aquatic organisms from aquaculture, marine, and inland sources, 33.8 million of which were consumed directly by the Chinese – almost a third of world totals. At least there, the Blue Revolution seems to have accomplished everything it promised.⁶⁶

The results of these programs elsewhere have been quite mixed. As [fig. 9.2](#) shows, marine fish production and per capita seafood consumption quickly multiplied in Ghana, Cuba, and Mexico with these forms of aid but later stagnated or collapsed when the support went away. Portuguese-ruled Angola was one of the world's first major exporters of fishmeal after the Second World War, but the Angolan industry almost closed down when bacteriologists discovered that air-dried Angolan fishmeal harbored an astounding

⁶⁵ Schaefer, "The Potential Harvest from the Sea," *Transactions of the American Fisheries Society* 94 (1965): 123–28; D. L. Alverson et al., "How Much Food from the Sea?" *Science* 24 Apr. 1970: 503–5; Idyll, *The Sea against Hunger*, 20–23.

⁶⁶ FAO statistical databases; Hiroshi Kasahara, "Confidential Report on National Fisheries Institute, Ecuador," 6 Nov. 1963, SIO-AC3, 4/210; *Pesca* Aug. 1961: 26–27; Dec. 1961: 49–50; May–June 1962: 21–29, 37–39, 70; July–Aug. 1962: 23–28; June 1966: 74; Mar. 1967: 36; Aug. 1968: 10–21; Nov. 1971: 30–33; Apr. 1972: 20–29; Alonso Aguilar Ibarra et al., "The Political Economy of Marine Fisheries Development in Peru, Chile and Mexico," *JLAS* 32 (2000): 514–16, 519–25.

diversity of *Salmonella* strains. This raised fears that contaminated animal feeds were responsible for bacterial infection in pigs and poultry and for food poisoning in human consumers. Meanwhile, little of this fish made it to the stomachs of Angolan nationals, and the industry later collapsed for reasons similar to Peru.⁶⁷ For many years, Sri Lanka was considered one of the great success stories of small-scale fishery industrialization. Unlike most countries, its postcolonial government decided it could not afford to follow expert advice and import large boats and canning plants. In 1959, the FAO sent Finnish boat construction expert Erik Estlander to Sri Lanka to build a fleet of small motorized trawlers. By 1962, there were 600 boats of his design operating in this island nation; by 1977, there were 2,500. These efforts resulted in immediate increases in Sri Lanka's national catch from 36,000 tons in 1956 to 57,000 tons in 1961. By the mid-1970s, the country was a major exporter of tuna and shark fin. For most coastal peasants living on the southern half of the island, however, Sri Lanka's Blue Revolution can only be described as "dismal": it benefited a tiny segment of the population and focused overwhelmingly on high-value fish that were consumed by distant city dwellers and foreigners. Per capita fish consumption barely improved over the course of this program.⁶⁸ Ethnic Chinese entrepreneurs introduced motorized fishing trawlers to Indonesia in 1966. These boats dramatically increased the country's marine fish production but were used indiscriminately to sweep the sea for one species after another – much of which ended up as fishmeal. These changes caused so much social and ecological disruption that major riots broke out in the late 1970s and early 1980s. Under intense political pressure, President Suharto banned the use of trawlers within Indonesia's territorial waters in 1983. In 1971, the Gilbert & Ellice Islands Colony signed a lucrative agreement with Van Camp Sea Food to develop a locally based fishing industry, but Hurricane Bebe in 1972 destroyed the entire fleet, and the program along with it. Similar problems also beset fishery industrialization programs in Panama, French Polynesia, Malaysia, and the Philippines during 1960s and 1970s.⁶⁹ Even the outspoken promoters of these programs at the FAO expressed concern that the

⁶⁷ Pesca June 1961: 32–33; July 1961: 36; Nov. 1967: 16–20; P. R. Edwards, "Salmonellosis: Observations on Incidence and Control," *Annals of the New York Academy of Sciences* 70 (1958): 598–613; K. W. Newell et al., "Salmonellosis in Northern Ireland, with Special Reference to Pigs and Salmonella-Contaminated Pig Meal," *Journal of Hygiene* 57 (1959): 92–105.

⁶⁸ Pesca Dec. 1962: 57–58; Paul Alexander, "The Modernization of Peasant Fisheries in Sri Lanka," in *Marine Policy and the Coastal Community* (London, 1976); Alexander, "Lessons from Pacific Technology Transfer and Fishing Communities: The Sri Lankan Experience," in *Development and Social Change in the Pacific Islands* (London and New York, 1989).

⁶⁹ Pesca May 1965: 30–34; Nov. 1966: 38–40; Bailey, "The Blue Revolution"; Bailey, "The Political Economy of Marine Fisheries Development in Indonesia," *Indonesia* 46 (1988): 25–38; Macdonald, *Cinderellas of Empire*, 180–81.

overwhelming majority of the increase in global fish production went “to expand consumption of pig and poultry products in high income countries and . . . *made little impact on dietary deficiencies in the developing world.*”⁷⁰

Peru’s fishing executives were quite sensitive to the criticism that 99 per cent of Peru’s fish production ended up in the First World. To try to make amends, the Clínica Anglo-Norteamericana in Lima initiated a program funded by the SNP and U.S. National Institute of Health in 1961 to test the nutritional attributes of fishmeal for direct human consumption. Medical outposts in Lima’s impoverished shantytowns provided malnourished children to be used as guinea pigs. They were fed soup, bread, and pasta fortified with fishmeal produced by an experimental South African refinery. One dangerously underweight infant, “Isabelita,” was fattened up on fishmeal and turned into a propaganda tool by the Peruvian fishing industry (fig. 9.3). Entrepreneurs also built pilot plants for producing “fish protein concentrate” in the United States, Sweden, Morocco, Peru, and Chile, often with international funding from organizations such as UNICEF. Advocates usually neglected to mention, however, that large quantities of isopropyl alcohol or hexane solvent were needed to remove the rancid fish odor from fishmeal, which destroyed much of its nutritional value. In January 1962, the U.S. Food and Drug Administration determined fish protein concentrate to be unfit for human consumption, leading Peruvian fishmeal producers to drop their support for this project. This revealed their cynical intention: to gain a foothold in the U.S. processed-food industry.⁷¹ Other programs to increase Peruvian fish consumption also accomplished little of substance, with the marked exception of a network of government hatcheries that introduced rainbow trout (*Oncorhynchus mykiss*) and lake trout (*Salvelinus namaycush*) to highland lakes and rivers. They did so, however, at the cost of driving to extinction a fish species endemic to Lake Titicaca (*Orestias cuvieri*). Per capita consumption of fish in Peru actually declined during the 1960s while the country was the world’s largest fish producer – an astounding case of ecological injustice for the nation’s poor.⁷²

⁷⁰ Their emphasis; *The Prospects for World Fishery Development in 1975 and 1985*, FAO Fisheries Circular no. 118 (Rome, 1969), 1.

⁷¹ Pesca Oct. 1960: 5–8; Aug. 1961: 13–21; Sept. 1961: 16–37, 45; Mar.–Apr. 1962: 43; July–Aug. 1962: 23–28; Nov. 1962: 67–69; Jan.–Feb. 1963: 41–48; June 1963: 57–63; Sept. 1963: 14–20, 52–54; Sept. 1964: 14–20; Apr. 1972: 28–32.

⁷² Pesca Nov. 1960: 37; Oct. 1962: 22–23, 57–59; Nov. 1962: 67–69; Jan. 1964: 15–27, 35–45; Feb. 1964: 11–22; Dec. 1964: 11; Apr. 1965: 22–24; Jan. 1966: 11, 30; June 1967: 22–24; Sept. 1967: 20–22; Oct. 1967: 16–18, 24–25, 28; Nov. 1968: 8–10; Nov. 1969: 12–15; Hernán Ortega and Max Hidalgo, “Freshwater Fishes and Aquatic Habitats in Peru: Current Knowledge and Conservation,” *Aquatic Ecosystem Health & Management* 11 (2008): 257–71; Joan Martínez-Alier, “Ecology and the Poor: A Neglected Dimension of Latin American History,” *JLAS* 23 (1991): 629–30.

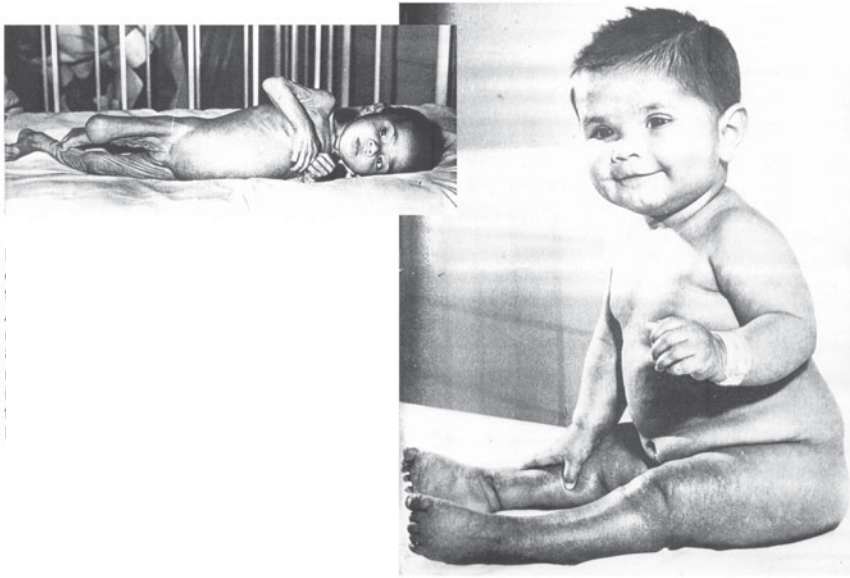


FIGURE 9.3. “Isabelita,” the Peruvian fishing industry’s poster child for the end of world hunger. With a diet of pasta fortified with fishmeal, physicians at the Clínica Anglo-Norteamericana raised the weight of this dangerously malnourished infant from 3.5 kg at 8 months of age to 9 kg at 12 months. These images were reproduced in a number of Peruvian periodicals, including the front page of the archconservative daily *La Prensa*. Similar images often appeared in international publications touting the production of food from the sea. *Source: Pesca*, Aug. 1961, reproduced with permission.

Replacing the Guano Birds

The ecological injustice and destructiveness of Peru’s Blue Revolution looks even worse when we consider the problems it caused for Peru’s attempts to participate in the Green Revolution. During the late 1950s and 1960s, an alphabet soup of international organizations gave concerted attention to increasing the production and consumption of fertilizers in the Third World. Malthusian fears of overpopulation also provided enormous impetus to these programs. Indonesia, India, and several other postcolonial states built highly successful input-substituting fertilizer industries with foreign aid and expertise, but similar attempts by the People’s Republic of China (PRC) started out disastrously. With the help of the Soviet Union and Czechoslovakia, China brought a half-dozen coal-powered fertilizer plants on line just in time for the Great Leap Forward of 1958–59, but the country discovered the hard way that industrialized agriculture remains vulnerable to climatic and logistical disruptions. Thirty million people died during the “Three

Bad Years” that followed. The response of PRC planners to this carefully hidden catastrophe vividly illustrates the centrality of fertilizer to Green Revolution programs to increase the world’s food supply. China immediately commissioned Western European engineers to build a natural gas-powered urea plant and aggressively developed homegrown designs for large- and small-scale plants. These efforts soon turned China into the world’s largest producer and consumer of manufactured fertilizer in the world and contributed tangibly to the improvement of crop yields, food security, and meat consumption in the country. They did so at the cost of producing air, soil, and water pollution on a scale that has caused nearly all of China’s major lakes and estuaries to become choked with algae and the whole earth to warm up.⁷³

Development planners gave similar attention to the fertilizer situation in Latin America. In most countries, population growth considerably outpaced increases in agricultural production during the 1950s. Urban areas and food consumption grew even more explosively, with clamor for rural land reform and social revolution intensifying in close parallel, especially after the triumph of the Cuban Revolution of 1959. These trends were particularly worrisome in Peru. The development of import-substituting chemical industries to produce concentrated fertilizers provided a popular strategy for easing these burdens. From the agronomist’s perspective, Peru’s concentrated fertilizer usage actually compared quite favorably to the rest of the world. In 1963, Peru consumed 45 kilograms of nitrogen, phosphorus, and potassium (NPK) fertilizer per hectare cultivated. This slightly surpassed the United States and Canada (at 44 kg/ha) and came close to the average for all developed countries in the First World and Communist Bloc (50 kg/ha). It greatly surpassed levels in Latin America (12 kg/ha) and the world as a whole (27 kg/ha). These amounts actually represented a significant decrease from the mid-1950s, when Peru used nearly 100 million kilograms of concentrated NPK fertilizer a year at rates of consumption that ranked ahead of most First World nations. Eighty-five percent of this came directly from Peru’s guano birds. Chile looked even better than Peru in these national accounts, thanks to its nitrate industry and heavy importation of phosphate and potassium. Peru’s situation looked very different from the point of view of population technocrats, however. In 1963, it only consumed 9.2 kilograms of NPK fertilizer per person, compared to 46 kg in North America, 33 kg in developed countries, and 15 kg for the world population as a whole. Developmental economists projected that Peru would need to bring a whopping one million hectares of new land into more intensive

⁷³ Jung-Chao Liu, *China’s Fertilizer Economy* (Chicago, 1970); Justin Yifu Lin and Dennis Tao Yang, “Food Availability, Entitlements and the Chinese Famine of 1959–61,” *Economic Journal* 110 (2000): 136–58; Ma et al., “Nitrogen Flow and Use Efficiency”; Smil, *Enriching the Earth*, 116–17, 124–25, 167–70.

cultivation over the coming decade just to keep up with the country's expanding population.⁷⁴ It is important to realize that these statistics did not include traditional manures. For example, they fail to account for Chilean wheat farmers' long reliance on nitrogen-fixing clover and alfalfa, the grazing of cattle, and inputs of Andean silt to maintain the productivity of their crops.⁷⁵ By emphasizing manufactured fertilizers, developmental economists of this era greatly exaggerated the problems facing Third World farmers, in the same way that their calculations of gross national product automatically exaggerated the economic production of cold versus tropical countries by crediting the consumption of energy to produce winter heat.

Building a new industry to replace the guano birds proved more challenging than expected. Peru's first superphosphate plant opened in 1957, but it depended on imported phosphate rock and quickly went bankrupt once the country's guano birds bounced back from the 1957–58 El Niño. Three years later, Fertilizantes Sintéticos S.A. (Fertisa) opened an ammonium nitrate plant at the mouth of the Rímac River in Callao modeled after similar plants in Colombia and Mexico. It burned heavy fuel oil produced in northern Peru and was a notorious emitter of sulfur oxides and particulates. Thanks to tariff protections, Fertisa at least made a profit but still barely made a dent in fertilizer imports.⁷⁶

Political change gave a notable boost to these endeavors. The presidential election of 1962 ended in a virtual three-way tie, and a reformist group of military officers took command of the Peruvian state for a year to break the impasse. Presaging the events of 1968, these officers embraced a closely controlled approach to economic development similar to other bureaucratic-authoritarian governments of the era. They immediately took measures to reign in the fishmeal industry's free-for-all and created an Institute of National Planning to supervise a series of technocratic commissions charged with laying out a new course for Peruvian society.⁷⁷

To this end, CAG was reorganized as the Corporación Nacional de Fertilizantes (CONAFER) in 1963 and directed to take part in a five-year National Fertilizer Plan aimed at increasing Peru's production of synthetic fertilizers. CONAFER did not think small. The cheapest project it considered would

⁷⁴ Organización de Estados Americanos, *Análisis del mercado de fertilizantes de Argentina-Bolivia-Chile-Paraguay-Uruguay* (Washington, DC, 1961), iii, 172–73; CEPAL, *El uso de fertilizantes en América Latina*, Doc. E/CN.12/760 (1966), 1–6, 8, 11–12; CEPAL, *La oferta de fertilizantes en América Latina*, Doc. E/CN.12/761 (1966), v, 102–5.

⁷⁵ Claudio Robles-Ortiz, "Agrarian Capitalism in an Export Economy: Chilean Agriculture in the Nitrate Era, 1880–1930" (Ph.D. diss., University of California, Davis, 2002).

⁷⁶ Thyrele Robertson, *The Peruvian Fertilizer Industry: Present Situation and Future Prospects* (Lima, 1968), 58; CEPAL, *El uso de fertilizantes*, 43–45, 90–95; CEPAL, *La oferta de fertilizantes*, 106–7.

⁷⁷ Pesca July–Aug. 1962: 52–53; Sept. 1962: 22–24, 62; Klarén, *Peru*, 320–22; O'Donnell, *Modernization and Bureaucratic-Authoritarianism*.

have spent US\$20.9 million to build a natural gas-powered plant outside Paita capable of producing 200 tons of ammonia and 340 tons of urea each day.⁷⁸ Peru's military government instead gave the go-ahead to another state-owned enterprise. The Development and Reconstruction Corporation of Cuzco wanted to build a 120-Mw hydroelectric plant on the Urubamba River within sight of Machu Picchu but needed a large electricity consumer to justify the "need" for such a large project in this thinly settled area. An energy-intensive ammonia plant fit the bill nicely. National security concerns also drove this decision. The province just to the east was the site of a bloody confrontation over land reform and supported a small guerrilla army of communist insurgents. The military government hoped to head off these threats by breaking up twenty-three haciendas and distributing their land to 14,000 colonists who would be taught the latest techniques of scientific agriculture. This electrolytic fertilizer plant thus became central to the military's strategy for agrarian reform. The junta's successor, University of Texas-trained architect Fernando Belaúnde (president 1963–68, 1980–85), hoped to expand the use of settlement programs of this sort to relieve population pressure in the country, and planned to build a 1,500-kilometer highway through the jungle wilderness along the eastern edge of the Andes to connect these endeavors.⁷⁹

The result was a fiasco. A German contractor completed this highland plant for the enormous sum of S/.648 million.⁸⁰ When it opened in 1965, it had a productive capacity *ten times* greater than existing demand for purchased nitrogen fertilizer in all of southern Peru. The plant quickly filled its warehouse and had to shut down in May 1967. Plant managers made a deal to distribute their wares on the coast far away, but when they reopened, they could not meet their production goals – or even cover the interest on their operating loans. This boondoggle had grown too big to be allowed to fail, however, so the government kept it in operation, despite chronic unprofitability. Today, travelers to Machu Picchu can still see this monument to state developmentalism. The Cachimayo plant is the only industrial complex of any significance on the railway from Cuzco, where it is still surrounded by fields cultivated with the ancient Andean digging stick (*taki chaclla*). A huge landslide caused by the 1997–98 El Niño buried the Machu Picchu hydroelectric plant under 28 million cubic meters of rock, water, and mud. Against expert advice, the Peruvian state rebuilt the plant at a cost of US\$53 million. It reopened to great fanfare in 2001, proving that Peru could recover

⁷⁸ Equal to US\$108 million in 2007; *BCONAFER* 1 (July 1963): 3–4; 4 (Jan.–Apr. 1966): 13–23; *MCONAFER* 2 (1965): 9–14; Robertson, *The Peruvian Fertilizer Industry*, 14–17, 32, 55.

⁷⁹ Klarén, *Peru*, 321, 327–32; Julio Cotler, *Clases, estado y nación en el Perú* (Lima, 1978), 345–47.

⁸⁰ Equal to US\$129 million in 2007.

from natural disaster but dug the financial hole needed to replace the guano birds ever deeper.⁸¹

To compound this disaster, Peruvian officials allowed the guano industry to pass into oblivion in a doomed attempt to make room for other industrialization programs to succeed. Environmental conditions in the Pacific switched rapidly from La Niña to El Niño during the first months of 1965 and continued this way until the middle of 1966. Nesting data produced by CONAFER's island guardians showed that the breeding guano bird population crashed from a post-1957 high of 28.2 million in May 1964, to 12.3 million in March 1965, to three or four million birds the next year. People living in Lima and other coastal cities did not need experts to tell them something terrible was going on. Tens of thousands of starving birds descended on urban markets in search of food during the crisis. Millions more wandered listlessly along the coast waiting for death. Peru's world-famous guano industry died in full public view.⁸²

This event caused enormous uproar, both in Peru and abroad. Many scientists and journalists faulted the fishmeal industry for this situation. Luis Gamarra upbraided them for destroying the "climax state" of Peru's marine environment and demanded that the industry concede to strict measures to protect the birds. The minister of agriculture, agronomist Rafael Cubas, used the opportunity to scare Peru's fishing magnates into funding a program to produce marine fish for direct human consumption. William Vogt made a brief visit on behalf of the Conservation Foundation to put in his two cents, and the Smithsonian Institution and Comité Nacional de Protección a la Naturaleza tried to drum up interest in an international conference focused on the guano birds' plight. News of this disaster even reached the United Kingdom's Prince Philip, a longtime friend of Peruvian conservationists, who "call[ed] for emergency action . . . to safeguard this unique Peruvian asset." An editorial in *El Comercio* went even further: "It would not be surprising if the extinction of the guano birds were closely followed by the extinction of the anchoveta."⁸³

Representatives of the fishing industry preferred to blame El Niño for the birds' demise. Citing fish population expert Benny Schaefer, they argued that

⁸¹ Robertson, *The Peruvian Fertilizer Industry*, 18–19, 22–25; MCONAFER 4 (1967): 14; Bernabé Calderón, "Machu Picchu vuelve a dar luz," *El Comercio* 25 May 2001: A11.

⁸² CEL; *Inf.Inst.Mar* 10 (1966); Trygve Sparre to Wib Chapman, 2 Apr. 1964, p. 9; Rómulo Jordán to John Kask, 27 Jan. 1966; Alfredo Freyre to Milner Schaefer, 3 Feb. 1966, SIO-AC3 3/174, 4/178; Tovar et al., "Monthly Population Size of Three Guano Bird Species."

⁸³ MCONAFER 2 (1965): 13, 33–37; 4 (Jan.–Apr. 1966): 57–60, 67–69, 94–108; *Pesca* May 1966: 37–40; Sept. 1966: 21–23; *Mem.Inst.Mar* (1966): 36–38; William Warner, "Preliminary Proposal for a Conference on Peruvian Marine Research," 2 June 1966; Carlos Barreda to Milner Schaefer, 26 May 1967, 30 June 1967; Schaefer to Barreda, 6 June 1967, SIO-AC3 4/184, 4/187; Prince Philip to Felipe Benavides, 5 Apr. 1966, Biblioteca Municipal, Pueblo Libre, Peru, special exhibition, Apr. 2001.

fish were far more resilient to climatic variation than their predators: “Self-renewable resources, like anchoveta, have to maintain a certain dynamic balance. If for some reason the population decreases, the rate of renewal increases, so that the population recovers its balance.” From their point of view, there was only one rational path forward: full replacement of the “inconsistent, obsolete, anti-economic guano industry” with a chemical fertilizer industry capable of expanding “at a rate compatible with population increase and just expectations of the elevation of food needs.”⁸⁴

The fishmeal industry could not hide the fact that it was facing grave problems of its own. However, unbridled expansion had allowed producers to glut the international fishmeal market during the early 1960s, which made it difficult for small, less efficient producers to make a profit. To stay afloat, many companies acquired exorbitant debts. According to the journal *Pesca*, total industry indebtedness in Peru reached S/.5.4 billion in 1965. Companies also tried to slash their payrolls, which resulted in labor unrest. Even Pedro Beltrán’s newspaper began calling for government intervention to help the industry.⁸⁵ Marine scientists also expressed worry about the ecological impact of the industry. Planktonologists working for Peru’s new oceanographic research institution, the Instituto del Mar del Perú (IMARPE), detected a “notable poverty” of anchoveta eggs during the 1965 El Niño. In April 1965, IMARPE and the UN Special Fund brought in an international team of experts from the FAO to analyze the mountain of fishing statistics that Peru had accumulated over the years. They came to the troubling conclusion that the fishing industry had caused a dramatic decrease in the average weight of anchoveta caught and significantly surpassed their estimates of the fishery’s maximum sustainable yield. They strongly recommended reducing the size of the fishing fleet and plant capacity to prevent the industry from destroying itself.⁸⁶

These findings inspired President Belaúnde’s government to issue a series of new regulations intended to limit the capacity of the fishmeal industry and save the guano birds. It again stopped issuing licenses for fishmeal plant expansion, created no-fishing reserves around the guano islands, and empowered CONAFER to issue fines to trespassing boats. Most importantly, it mandated a strict quota on anchoveta production during the 1965–66 fishing season of seven million metric tons and mandated the industry’s complete closure from June through August (when fishing activity was at a minimum, anyway). IMARPE recommended even more stringent regulations for 1966–67, including a six-week closed season (*veda*) during the summer

⁸⁴ *Informe singular de la Sociedad Nacional de Pesquería* (Lima, 1966); SNP, *Memoria*, 1964–1965 (Lima, 1965), 27–30, 43–44; SNP, *Memoria*, 1965–1966 (Lima, 1966), 25–28.

⁸⁵ Equal to US\$1.1 billion in 2007; *Pesca* June 1963: 15–23; July–Aug. 1963: 15–22, 52; Apr. 1964: 23; Aug. 1964: 17–23; Jan. 1965: 11–14; July 1965: 12–17; Nov. 1966, 14–20.

⁸⁶ *Mem.Inst.Mar* (1965): 23–26, 74–76; *Bol.Inst.Mar* 1, no. 4 (1967): 133–86.

to protect the new year-class of anchoveta fry (*peladilla*) and a five-day workweek for the entire industry.⁸⁷

The SNP cooperated with most of these mandates but employed its own expert to check IMARPE's math. In April 1966, Benny Schaefer traveled to Lima at the fishing industry's expense to do a reanalysis of Peru's 1964–65 fishing data. As we have seen, Schaefer had long served as an advisor to Peru, and he was considered by many to be the Pacific's *experto número uno* when it came to marine fish populations. Schaefer was also one of the world's leading proponents of the use of the concept of maximum sustainable yield (MSY) as a tool of fishery management. During the mid-1950s, he developed a technique based on Raymond Pearl's logistic curve to quantify the reproductive dynamics of an exploited fish population using total catch statistics. The Schaefer Model, as it became known, provided a convenient management tool because it provided an objective measure of overfishing focused on fishing effort.⁸⁸

Schaefer's intervention abruptly changed the way officials viewed the guano versus fishmeal controversy. His initial calculations showed that production in 1964–65 had indeed come close to surpassing the "long-term" MSY of the anchoveta fishery and required aggressive regulatory action. Schaefer then took the innovative step of including estimates of guano bird predation in his model of anchoveta population dynamics. This allowed him to raise his long-term estimate of MSY for the entire anchoveta fishery to a total of ten million tons per year. From this perspective, the 1965–66 El Niño had provided a windfall for the fishing industry. The abrupt decline in the guano bird population meant that humans could now safely harvest up to 9.5 million metric tons of anchoveta per year. Schaefer left it to Peru to decide whether they wanted to maximize fishmeal production or give some fish to the guano birds. "Such a choice cannot be avoided, the only question is whether it will be made on the basis of objective analysis or through . . . emotional arguments," Schaefer told Peruvian officials – though privately he was not planning to shed any tears if "we should 'lose' guano."⁸⁹

⁸⁷ *Inf.Inst.Mar* 1 (1965); 7 (Oct. 1965); 14 (Dec. 1966); *BCONAFER* 4 (Jan.–Apr. 1966): 77–82; *Pesca* May 1965: 11.

⁸⁸ *Pesca* Nov. 1960: 32–33; Dec. 1964: 36; Tim Smith, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855–1955* (Cambridge and New York, 1994), 249–66; Finley, "The Tragedy of Enclosure," 99–101, 188–90, 317–18, 465–73.

⁸⁹ Carlos Otero to Schaefer, 20 Apr., 9, 10 Nov. 1965; Schaefer to Otero, 20 May, 15 Nov. 1965; Schaefer to Garth Murphy, 18 May 1966; Schaefer to Alfonso Elejalde, 19 May 1966; L. K. Boerema to Schaefer, 20 May 1966; Schaefer to Boerema, 2, 29 June 1966; Schaefer, "Progress Report Concerning Analysis of the Dynamics of the *Anchoveta* Fishery," 30 June 1966; Alfredo Freyre to Schaefer, 26 Aug. 1966; Schaefer to Freyre, 6 Oct. 1966; marginalia by Schaefer in Warner, "Preliminary Proposal for a Conference on Peruvian Marine Research," 2 June 1966, SIO-AC3, 4/178–79, 4/181, 4/187.

While Schaefer crunched these numbers, a nasty confrontation was brewing. Anchoveta fishermen were rapidly approaching the seven million ton quota set by IMARPE for 1965–66, and the minister of agriculture, who was no friend of the fishmeal industry, was prepared to shut down the fishery the moment it surpassed it. Plant owners as a group were almost evenly divided about the merits of government efforts to protect anchoveta stocks. Labor unions and independent boat owners, however, were staunchly opposed to catch quotas and a closed season. A handful of small plant owners and southern producers wanted exemptions from the national quota to help them compete against the industry's "big boys" and to prevent Chilean boats from taking the fish they left behind. Schaefer's findings enabled government officials in good conscience to allow fishing to continue well beyond the original quota until the scheduled 1 June closure date, for a total of 222 days worked during the 1965–66 season. Schaefer's calculations made it politically palatable to implement the first closed season in the history of the Peruvian fishing industry.⁹⁰

In subsequent years, Schaefer and other population biologists helped IMARPE refine its methods for estimating the maximum sustainable yield each season and convinced fishmeal manufacturers to embrace the quota system. In many ways, these efforts constituted one of the most rigorous technocratic procedures for managing a marine fishery the world had ever seen. However, the quotas at the core of this system did little to control fishing intensity – a problem that Belaúnde's government exacerbated by providing tax breaks to companies that replaced old, wasteful factories and boats with high efficiency equipment. This meant progressively shorter fishing seasons and smaller paychecks for the industry's shrinking workforce: from 166 days in 1966–67 down to 116 days in 1971–72.⁹¹

The fishing industry's embrace of conservationist principles and the technocratic ideal cut out the legs from under the defenders of the guano industry. The guanay and piquero populations failed to recover from the 1965–66 El Niño, and the crisis soon began to affect other marine birds. In 1967, large flocks of hungry pelicans again showed up at markets in Lima, and scientists began noticing increased numbers of dead blue-footed boobies, terns, and other species. Some tried to blame this on chemical pesticides such as DDT, which Peruvian farmers were consuming at the rate of several thousand tons a year, but the long-term stability of the Peruvian pelican population argues strongly against this. It only declined slightly from an average of 270,000 breeding adults during the period 1957–64 to 240,000 in 1965–71, whereas in North America, brown pelican populations dropped so severely from pesticide exposure that they came to be classified as an endangered species.

⁹⁰ *Pesca* Apr. 1966: 36; May 1966: 9; Sept. 1966: 14–18; Dec. 1966: 15–18.

⁹¹ *Mem.Inst.Mar* (1967): 18–19, 34–36; *Pesca* Jan. 1967: 12–20; Jan. 1968: 8–12; Feb. 1968: 22; June 1967: 24–26, July 1967: 29–31; Sept. 1968: 9–13; Apr. 1968: 24–27, 30; Caravedo, *Estado, pesca y burguesía*, 63, 123–24.

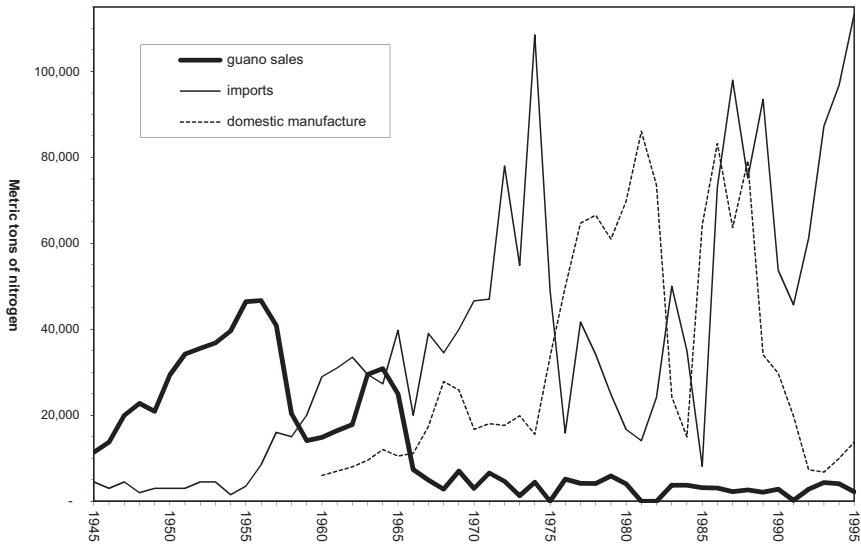


FIGURE 9.4. Nitrogen fertilizer consumption in Peru, 1945–1995.

The Peruvian Congress held one last high-level meeting to discuss the guano birds' fate in June 1967. CONAFER officials faced a chorus of opposition when they demanded even greater limitations on the anchoveta fishery and made the grave tactical error of insinuating that IMARPE scientists were stooges for the fishing industry. This poor performance sealed the fate of the guano birds.⁹²

Meanwhile, Peruvian farmers struggled mightily to find a replacement for the cheap fertilizer they once enjoyed. As [fig. 9.4](#) shows, total fertilizer consumption in Peru plummeted in 1966 as Belaúnde's government tried to reign in imports to jump-start fertilizer manufacturing. Fertilizer imports soon rebounded, but protective tariffs made them prohibitively expensive for most farmers. This situation contributed tangibly to the malaise that affected producers of food and export crops during the late 1960s and ratcheted-up pressure on the central government to do something decisive to fix this rural crisis.⁹³

In October 1968, after months of secret planning, the Revolutionary Government of the Armed Forces overthrew Belaúnde's financially beleaguered, gridlocked, and scandal-ridden administration. Taking over where the previous military regime had left off, General Juan Velasco Alvarado

⁹² *Mem.Inst.Mar* (1967): 21–22, 30, 65; *Bol.Inst.Mar* 1, no. 10 (1968): 523–46; 2, no. 7 (1972): 451–53; Tovar et al., “Monthly Population Size of Three Guano Bird Species”; Arriaga, “Contaminación Pacífico Suroriental,” 35; Johnsgard, *Cormorants, Darters, and Pelicans*, 131, 139–40.

⁹³ Hopkins, *Desarrollo desigual y crisis en la agricultura*, 103–8, 185; Elena Álvarez, *Política económica y agricultura en el Perú, 1969–1979* (Lima, 1983), 155–56.

and his associates installed a bureaucratic-authoritarian state dominated by technical experts – many with training at Peru's Centro de Altos Estudios Militares. This reformist, center-left government gradually took control of the means of production in Peru, starting with unpopular foreign-owned companies such as the Peruvian Corporation of London and the International Petroleum Company. In 1969, it launched a massive agrarian reform meant to remedy a situation in which less than 1 percent of landowners owned a whopping four-fifths of all agricultural land in Peru. It eventually distributed 8.5 million hectares representing 60 percent of Peru's farm income to 375,000 families. This land reform actually went much farther than the Mexican Revolution.⁹⁴

The Revolutionary Government of the Armed Forces also dedicated itself to bringing the full benefits of the Blue Revolution to Peru. At least at first, it allowed the fishmeal industry to operate much as before and concentrated instead on exploiting other species of marine fish. In 1969, the Revolutionary Government invited a team of experts from the Japanese Fishery Agency to develop a comprehensive plan for developing food fish production, which started off by authorizing a Japanese firm to reopen whaling operations from Paita to produce whale sausage for Peru. In 1970, it formed an agreement with the UN Development Programme and FAO to create a state-owned company charged with producing and marketing fish for direct human consumption. In 1971, the U.S.S.R. offered a credit of US\$30 million to construct a massive processing facility in far northern Peru capable of producing 200,000 tons of fish per year. On the consumption side, the military government took the radical step in 1972 of prohibiting beef sales in Lima for fifteen days each month to encourage fish and chicken purchases. Thanks to these programs, marine fish consumption in Peru increased abruptly from 133,663 metric tons in 1968 to 342,455 in 1973 to 466,780 in 1980, and has never dropped below 200,000 metric tons a year, even during severe El Niño events. On average, each Peruvian today consumes a modest 40 kcal of seafood per day: about twice what they did in 1968.⁹⁵

Increasing the supply of artificial fertilizer was also an important part of the Revolutionary Government's economic strategy. It abolished import taxes on fertilizer soon after taking power and eventually developed an elaborate program of price controls and subsidies to encourage their use. In 1975, Petroperú opened a urea plant as part of its much-anticipated Gran Complejo Industrial Petroquímico del Norte. Within two years, this factory more than tripled the supply of nitrogen fertilizer produced in Peru and took a huge bite out of fertilizer imports, freeing up precious foreign exchange. Much of this fertilizer was used to produce feed for poultry farms, which

⁹⁴ Klarén, *Peru*, 336–49; Alfred Stepan, *The State and Society: Peru in Comparative Perspective* (Princeton, NJ, 1978), pt. 2.

⁹⁵ FAO statistical databases; *Pesca* Dec. 1968: 27; Oct. 1969: 20–25; Apr. 1970: 11–14; Sept. 1970: 8–15; Mar. 1971: 8–10; July 1971: 18–21; Apr. 1972: 5.

enabled Peruvian poultry consumption to increase from 45,630 metric tons in 1968 to 140,059 in 1977. By burning up the country's petroleum reserves, Peruvian agriculture briefly escaped the ecological limitations inherent to extracting nutrients from Peru's marine environment. From 1975–91, the Peruvian fertilizer industry produced 918,225 metric tons of nitrogen fertilizer – an amount almost identical to that produced by Peru's guano birds from 1909–66. It did so, however, at unsustainable ecological and economic cost. Chicken production fell back to earth first, and per capita meat consumption in Peru actually declined from 1961 to 1991, before poultry producers began to use Peruvian fishmeal in large quantities. The removal of state protections and renewed foreign competition eventually left Peruvian fertilizer production about where it had been at the end of the War of the Pacific. In 2000, with the exception of 15,661 metric tons of guano supplied to organic farms and other traditional manures, Peru produced *zero* nitrogenous fertilizer. For the first time in its 2,500-year history, input-intensive agriculture in Peru has become almost totally dependent on foreign fertilizer supplies. Import-substituting industrialization turned out to be far more volatile as a strategy of economic development than depending on the guano birds.⁹⁶

The Green Revolution in Mexico has received similar criticism. The growth of fertilizer production also proved impossible to sustain in Mexico during the long-lived economic crisis of the 1980s and privatization mania of the 1990s, when fiscal strictures forced the Mexican state to reduce its heavy subsidization of the industry. In November 1985, Mexico's Secretariat of Urban Development and Ecology (SEDUE) forcibly closed the fertilizer plant at Cuautitlán, throwing more than 1,000 state employees out of work, because the plant violated the 1982 Law for the Protection of the Environment requiring smokestack industries to use pollution control devices. By this date, Mexico City had become infamous for its horrific air pollution and other environmental problems caused by uncontrolled growth. This was the first time that this law had been used for this purpose and marked the symbolic beginning of a concerted governmental campaign to improve Mexico City's air quality. Even in its demise, this revolutionary fertilizer plant played an important role in Mexico's environmental history.⁹⁷ On the consumption side, input-intensive agriculture has been harshly criticized for creating enormous social inequalities. These continue to drive emigration from the countryside in central and southern Mexico to agricultural districts in northern Mexico and the United States, and to cities in both countries. In

⁹⁶ FAO statistical databases; Empresa Nacional de Comercialización de Insumos, *ENCI y la comercialización de fertilizantes*, 6, 12–14; Álvarez, *Política económica y agricultura*, 39–42, 156–61.

⁹⁷ Gracia, ed., *Estado y fertilizantes*, 80–88, 184, 209, 277–78; Otto Friedrich, “A Proud Capital's Distress,” *Time* 6 Aug. 1984; Simonian, *Defending the Land of the Jaguar*, 183–84, 212.

parallel with its fertilizer advocacy, Guanomex also led a massive governmental campaign to expand the use of DDT and other organo-insecticides, which proved to be highly toxic to birds, particularly when these chemicals enter the marine food chain. The eventual replacement of these destructive chemicals with less persistent, but more acutely toxic pesticides has had the harsh side effect of increasing the hazards experienced by agricultural workers. Perhaps Mexicans can take satisfaction in the fact that they are now eating three times more meat per capita than Peruvians.⁹⁸

Like the guano and nitrate booms of the nineteenth century, the Green and Blue Revolutions involved fundamental changes in humanity's relationship to nitrogen, phosphorus, and the Pacific Ocean. In the case of the Green Revolution, the adoption of new, high-yielding varieties of grain was premised on the availability of large quantities of concentrated fertilizer. From Mexico, to China, to Peru, the quest to increase agricultural productivity inspired the creation of energy-intensive industries to put these elements in usable form. In the case of the Blue Revolution, the development of high-yielding chickens and pigs was premised on the availability of high protein feeds. For many years, a major share of this protein came from the Pacific coast of Peru. In both cases, these revolutions started out with the intention of improving the living standards of Third World peoples so that they would experience the demographic transition and avert Malthusian crisis and Marxist revolution. In the end, these programs became so entwined with developmental politics that they transcended the ideological divisions of the Cold War and resulted in fundamental changes to the Law of the Sea. Both revolutions dramatically increased the world's food supply but preferentially went to the production of meat, which enabled a portion of the world's population to become fatter but left billions thin or thinner than they have ever been.

The case studies in this chapter have revealed some of the environmental costs of these programs. The Green and Blue Revolutions both had roots in the guano industries of Mexico and Peru – further testimony of the importance of guano to modern history. As a further legacy, environmental scientists attained unprecedented authority over Peru's marine fisheries during the late 1960s. In both cases, however, government officials sacrificed the guano birds on the altar of developmentalism once it became clear they could not fulfill their aspirations for growth. As we will see in the concluding chapter, technocratic decisions of this sort ended up making the Pacific World a much deadlier place for birds, fish, and humans.

⁹⁸ Angus Wright, *The Death of Ramón González: The Modern Agricultural Dilemma* (Austin, TX, 1990); Hewitt, *Modernización de la agricultura*, 83–88; Cotter, *Troubled Harvest*, ch. 6.