The guano islands of Peru: the once and future management of a renewable resource

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SUMMARY

The Peruvian coastal guano islands and headlands have been among the world's best and worst managed of seabird nesting areas. The islands contained enormous deposits of seabird excreta or guano which was mined for fertilizer in the nineteenth century. In the early twentieth century, with guano deposits exhausted and bird populations almost exterminated by the exploiters, the Peruvian government nationalized the islands and began to manage them as a sustainable resource, protecting the birds, improving their nesting sites, and taking only the annual accumulations of guano.

Populations of the three principal guano-producing species, the Guanay Cormorant *Phalacrocorax bougainvilli*, Peruvian Booby *Sula variegata*, and Peruvian Brown Pelican *Pelecanus (occidentalis) thagus* recovered sufficiently so that their nesting colonies became space-limited. The Peruvians responded by fencing coastal headlands with predator-proof walls and the guano bird population increased ever further. In the 1960s, a commercial fishmeal industry developed for the anchoveta *Engraulis ringens*, the main food of the seabirds, leading to competition with the guano industry. Guano harvests fell to low levels. By 1972, the fishery had a vast excess capacity of boats and fishmeal plants and began to collapse because of low returns on investment. The collapse was accelerated by fishing during the 1972 El Niño, an oceanographic anomaly linked to reproductive failure of the anchoveta. Anchoveta populations remained low for a decade and the remaining fishery switched to sardina *Sardinops ocellata*, a slightly larger fish that could be canned. Fishing pressure continued on the anchoveta, supposedly to keep it from recovering and outcompeting the sardina, but in reality because fishmeal could be sold for hard currency on the international market, whereas sardina was sold domestically. Following the collapse of the anchoveta stock, seabird numbers only partially recovered and the guano industry abandoned many islands and headlands. Money for management sharply decreased as the government has struggled to pay for Peru's international debt and for a protracted conflict with two guerrilla movements. Hyperinflation has further eroded the government's ability to manage its natural resources.

The situation is extremely unpromising, but there are three elements that provide hope. First, guano is the ideal organic fertilizer and could be sold overseas for hard currency to the large and growing organic farming movement, as is being done with Namibian guano. Second, private and local efforts, such as those working to preserve Punta San Juan, a major penguin nesting area in southern Peru, provide a model for non-governmental management and protection of nesting areas. Finally, if Peru can overcome its political and security problems, it will again be a major destination for the nature tourism industry. The guano islands, only one of which is presently visited by a tourist boat, could become an important component of such tourism.

THE eastern boundary currents of the world's oceans are among the most productive of marine environments, originally supporting rich and diverse marine communities (Hutchinson 1950, Cushing 1971). More recently, these ecosystems have been severely over-exploited by humans, resulting in the collapse of exploited fishery populations. Management of natural resources in such areas is subject to conflicting needs by different exploiters (Schaefer 1970, Butterworth *et al.* 1988) and to complex interactions between exploited species (MacCall 1984).

The Peruvian Coastal Current or Humboldt upwelling is an excellent example of the problems facing such ecosystems. Originally endowed with

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enormous stocks of marine birds, mammals and fish, the upwelling's resources were over-exploited, leaving an impoverished resource base that makes a greatly diminished contribution to the national economy compared with previously (Schweigger 1964). In addition, the El Niño phenomenon, a temporary collapse of the upwelling's productivity (Walsh 1977), has made management of resources difficult because of the year-to-year uncertainty and its damage to the national infrastructure (Caveides 1975, del Solar 1983, Arntz 1986).

ISLAND TYPE AND DESCRIPTION

Island types

The islands of Peru have been discussed by Murphy (1925), Vogt (1942) and Hutchinson (1950), among others. There are at least 84 islands (Anon. 1962), as well as countless small offshore stacks (Figure 1). Combined with the coastal headlands used by guano birds, the total nesting area available for birds is 8,116 ha (Gonzalez 1952). The islands can be divided into

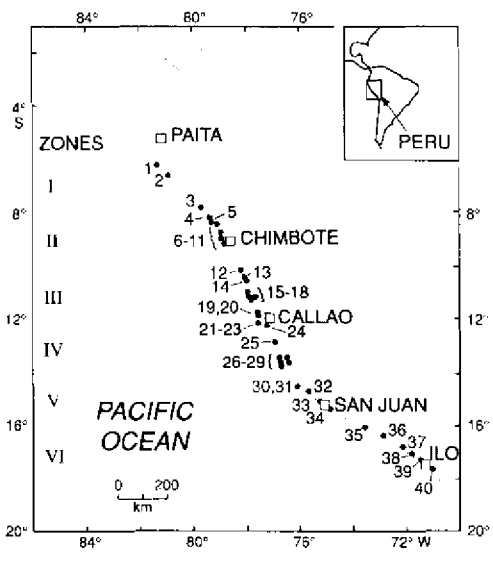

Figure 1. Distribution of Peruvian seabird guano islands and headlands by zones (after Tovar and Cabrera 1985): ZONE I: I. Lobos de Tierra (1), Lobos de Afuera (2), I. Macabi (3); ZONE II: I. Guñape S. (4), I. Guñape N. (5), I. Chao (6), I. Corcovado (7), I. Santa (8), I. Blanca N. (9), I. Ferrol (10), I. Tortuga (11); ZONE III: Pta Culebra (12), Pta Colorado (13), Pta Liera (14), I. Don Martin (15), Pta Salinas (16), I. Huampanú (17), I. Mazorca (18), I. Pescadores (19), I. Isleta (20); ZONE IV: I. La Cruz (21), I. Palominos (22), I. Cavinzas (23), I. Pachacamac (24), I. Asia (25), I. Chincha N. (26), I. Chincha C. (27), I. Chinca S. (28), I. Ballestas (29); ZONE V: I. La Vieja (30), I. Sta Rosa (31), Pta Lomitas (32), Pta San Juan (33), Pta Lomas (34); ZONE VI: Pta Atico (35), Pta La Chira (36), Pta Islay (37), Pta Jesus y Cocotea (38), Pta Coles (39), Morro Sama (40).

'guano islands', those islands sufficiently large and frequently used by the main guano-producing seabirds to merit protection, and 'non-guano' islands, which are either very small or larger, higher, and more disturbed than most of the guano islands (e.g. El Fronton, a prison island in Callao harbour at Lima; San Lorenzo, also in Callao harbour; and San Gallan, off Paracas). Lobos de Tierra and Lobos de Afuera, both off northern Peru, and La Vieja south of Paracas also have relatively few guano birds relative to their total area, but guano production has been sufficient to merit protection by guards.

Terrain, habitats and community

With the exception of the larger islands, most of the islands do not have beaches and are cliff-bound, some requiring elaborate gantries to allow access. In other cases, the shores are less vertical but are rendered inaccessible by oceanic waves and swell. A few islands such as Lobos de Tierra, two of the Chincha Island group and one of the Ballestas have low-energy sand or pebble beaches. Many of the less disturbed beaches are presently occupied by sea-lions *Otaria flavescens*. Isolated rock ledges and seacaves are often occupied by southern fur seals *Arctocephalus australis*. The surrounding waters are usually very deep, dropping off to hundreds of metres.

The islands themselves are mostly of andesite, extensively undercut on their lower portions with frequent seacaves and tunnels. The upper portions of the islands were formerly covered with thick deposits of guano (Hutchinson 1950). All of the original guano beds have been removed, leaving bedrock and gravel and at most two or three years of guano.

Except for Isla Lobos de Tierra in the far north where a single *Prosopis chilensis* tree occurred (Murphy 1925) until about 1978 when it was cut down (pers. obs.) and the high islands of San Gallan, La Vieja and San Lorenzo where 'loma' fog-zone vegetation occurs at upper elevations, the islands are virtually devoid of vascular plants (a few exist where planted and maintained by humans). The food chains are relatively short: detritivores and parasites exploit the birds or their by-products. The detritivores are eaten by predatory arthropods including scorpions, spiders and a lizard, with ants being almost completely absent (Murphy 1921, Duffy 1983a, 1991). The parasites include mallophaga, hippoboscid flies and ticks (Murphy 1921). The argasid tick *Ornithodoros amblus* reaches sufficiently high levels of infestation to force birds to abandon their nests and young, and can inhibit breeding altogether (Duffy 1983a). A lizard was introduced to several islands to control the ticks (Vogt 1939), but this may be ineffective because the breeding seabirds are aggressive to lizards and exclude them from the colonies (Duffy

1983a). Cats and rats are known to occur on a number of islands, but their effect on seabirds is unknown.

Seabird species and recent changes

There are 18 species of seabirds nesting on guano islands or along the coast in the upwelling area of coastal Peru (Murphy 1936). The most important numerically are the Guanay Cormorant *Phalacrocorax bougainvilli* and the Peruvian Booby *Sula variegata* which together comprised 92% of all seabirds off central Peru in 1977–1978 (Duffy 1983b). Peruvian Brown Pelicans *Pelecanus (occidentalis) thagus*, present only in small numbers in Central Peru, are more abundant on the northern islands of Lobos de Tierra and Lobos de Afuera. The relative abundances of the species have varied considerably over the past several centuries, in apparent response to human disturbance, excavation of the guano layer, and commercial fishing pressure (Hutchinson 1950, Jordán and Fuentes 1966).

Other species, present in small numbers compared with the cormorant and booby, include: Humboldt Penguin *Spheniscus humboldti*, Peruvian Diving-petrel *Pelecanoides garnoti*, four storm-petrels (Hydrobatinae), Red-legged Cormorant *Phalacrocorax gaimardi*, Neotropical Cormorant *P. olivaceous*, and Inca Tern *Larosterna inca* (Murphy 1936). Blue-footed Boobies *Sula nebouxii* nest only on Lobos de Tierra and Lobos de Afuera in northern Peru (Murphy 1936).

HISTORY OF THE ISLANDS AND THEIR SEABIRDS

The population dynamics of Peruvian seabirds are most affected by two factors: the El Niño phenomenon and human exploitation and competition (Jordán and Fuentes 1966, Duffy and Siegfried 1987). During the Inca period, disturbing the guano islands in the breeding season was a capital offence (Vogt 1942). Guano was used as fertilizer by the Incas on the adjacent mainland (Garcilaso de la Vega 1609, Buse 1972), although the extent of this practice has been questioned (Vogt 1942). The early Spanish used eggs in mortar while constructing the city of Lima (M. Plenge in Duffy *et al.* 1984). This would have greatly disturbed breeding at islands near Lima, but its effect on the adult birds is unknown. Overall, there are three principal determinants of past events and future prospects for Peruvian colonially breeding seabirds: exploitation (guano industry), competition (commercial fisheries) and policy direction (politics).

Guano industry

In the mid-nineteenth century, the discovery of guano's value as a fertilizer led to a 'guano rush' or 'Saturnalia' (Murphy 1981), as guano was used to maintain the productivity of farms feeding the industrializing cities of Europe and North America. Guano was mined and the young birds were fed to the workers (Murphy 1981). The removal of the guano substrate probably greatly reduced numbers of Peruvian Diving-petrels and Inca Terns (Hutchinson 1950), and probably also Humboldt Penguins.

By 1900, there was little remaining guano and few birds. The European and North American interests that had controlled the islands as surety for Peru's national debts relinquished most of them, the last remaining in British possession until the early 1920s. In 1909, the Peruvians made a remarkable decision that stands as one of the first and most effective examples of sustainable exploitation of a natural population by a government. Peru created a national company called La Compañia Administradora del Guano (The Guano Administration Company) to manage the islands and to restore guano production.

Two or four guards were placed on each island. Their main responsibilities were to keep unauthorized visitors off the islands, and to maintain the docks, buildings and equipment. The guards, trained by Peruvian scientists, made regular observations, sketching the distribution and breeding status of the birds on maps of each island. Those sketch maps were then used to make fairly precise estimates of the amount of guano produced (Jordán 1960, Valdivia 1960) and the harvest effort that would be needed to remove the guano.

To increase the numbers of breeding birds, the company began to clear stones and to smooth slopes, building walls to retain guano and increase booby nesting at cliff edges. The government passed laws to restrict boat and aircraft operations near islands and closed fishery areas surrounding the islands.

The islands' infrastructure was elaborate. Most of the inhabited islands have extensive housing on their leeward sides (pers. obs.) which was used for administration and housing of officials during guano removal. The guards usually lived in less elaborate cabins. During periods of guano extraction, the guano workers slept in makeshift tents in the nesting areas, although dormitories were provided on some islands. Hospitals or dispensaries were staffed during most guano extraction efforts, although the level of medical care varied widely and was frequently not maintained at the level set by the central administration. Water was provided by a tanker which pumped water into concrete cisterns as required. Some islands had running water, but the majority did not.

Guano removal after 1909 occurred only outside the breeding season during winter, even though seas are much rougher during that period. Several hun-

ity would have to be reduced by 50 to 75% and factories by 25%; if not, rising fixed costs of idle vessels combined with a reduction in reproductive success of anchoveta during El Niño would eventually cause the collapse of the fishery. In 1972, that dire prediction came true. To salvage the situation, most of the anchoveta fishery was nationalized and the new public company PESCA PERU began to scrap much of its newly acquired assets. Peru's coast became a graveyard of fishing boats, either tugging aimlessly at anchor or arrayed in neat rows in the desert, waiting to be cut up for scrap. Meanwhile the anchoveta failed to recover and the sardina *Sardinops ocellata* became increasingly common (Zuzunaga 1985).

The fishing industry remaining in private hands was directed by law to fish for food for human consumption. Unfortunately, such landings were paid for in Peruvian currency which became steadily less attractive because of inflation. Fishmeal could be exported and paid for in hard currencies. Private fishing ventures soon exploited a government regulation that fish unfit for human consumption could be turned into fishmeal by the companies. Fishing vessels either delayed returning to port or paid grossly undersalaried fishery inspectors to 'look the other way'. In addition, the government appears to have had a policy that the anchoveta were deliberately overfished to prevent their recovery in the belief that this would maintain the sardina stock.

The result for the guano birds was that their food remained scarce and bird numbers did not recover. The resulting low rate of guano production made it uneconomic to continue to maintain guards on many of the bird islands. The small numbers of birds that did attempt to nest on those unprotected sites fell victim to eggers and other disturbance, further limiting the ability of their populations to recover. At the present time, the guano administration, now part of the national fishmeal company, places guards only on islands with relatively large colonies and continues to harvest guano. Its managers and the scientists of the Instituto del Mar, the national marine research institute, continue to study and monitor the guano birds and the anchoveta, despite low salaries and limited operating funds.

Marine pollution

Pollution seems to have been relatively unimportant (Duffy *et al.* 1984). There is relatively little river discharge. Surface transport of waters is generally offshore, so oil is likely to be dispersed quickly and oiled birds unlikely to be washed ashore on beaches (Vogt 1942). The incidence of oil spillage near breeding colonies appears to be minor, but may be locally a problem in harbours where pollution controls are casual (pers. obs.). Persistent organochlorine pollutant and mercury levels also are low (Anderson *et al.* 1980, Gochfeld 1980, Risebrough *et al.* 1980), probably also because of offshore transport.

Economics and politics

In some ways, Peru's present problems can be traced to the 1972 collapse of the anchoveta fishery and the fishmeal industry. The fishmeal industry had generated a new source of income for the country's economy, 350 million dollars in 1969–1970, not controlled by the traditional upper class, but run at least in part by a new entrepeneurial class (Abramovich 1973). Jobs for 27,000 people employed by the new industry absorbed and further stimulated much of the early migration of Peruvians to the cities from traditional Andean farming communities (Hammergren 1981). This community became a strong constituency for the leftist military government of Velasco that attempted to revolutionize Peruvian society after seizing power in 1968.

The Velasco government decided to modernize Peru through heavy social spending (Tomczak 1981). This in turn generated a large foreign debt that, because of falling prices for Peruvian minerals and the sharp price increases in petroleum, could not be repaid without diverting money needed for investment in the growth of Peru's economy. The promises made

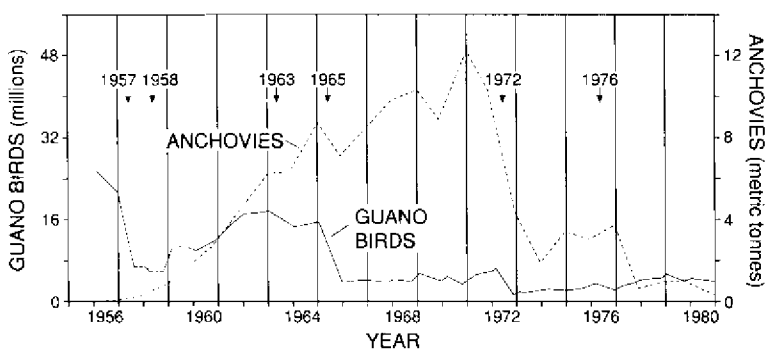

Figure 2. Changes in guano bird numbers and commercial landings of anchoveta in relation to El Niño occurrences (after Jordán 1982).

by the Velasco government to the Andean campesino population would not be kept by subsequent centrist or right-wing military and civilian governments which needed further international loans for growth. The Andes became fertile ground for the resurgence of leftist guerrilla groups, the Sendero Luminoso and Tupac Amaru (Bonner 1988). These in turn stimulated increased military spending by the government to suppress the movements and to maintain control of the country, further reducing the availability of funds necessary for social programmes and economic revival.

The penultimate president, the leftist Alan García, suspended payment of foreign debt to restore social spending. He then nationalized the banking industry which led to a massive exodus of private capital and a collapse of the financial system. Meanwhile, the Peruvian military, trained basically to fight conventional wars against Chile or Ecuador, blundered through the Andes and, through excessive and indiscriminate use of force and through 'disappearances' of peasants, converted neutral campesinos to guerrilla sympathizers (Bonner 1988).

The guerrillas acquired control of the coca-growing areas of northern Peru and thus had a stable source of foreign currency from the protection funds paid by the cocaine cartels (Anderson 1990). This financed increased guerrilla violence, much of it simply terrorism and assassination aimed at any and all social structures. The military, restrained by President García following particularly brutal actions against prison uprisings (one on the seabird island of Fronton; see Rivadeneira *et al.* 1986), simply stayed in their barracks with the result that control of the country slipped increasingly into guerrilla hands or into anarchy (Bonner 1988).

In 1990 (Guillermoprieto 1990), Peruvian voters expressed their disdain with traditional politics by electing a newly established party to form the government. That government is headed by a newcomer, Alberto Fujimori, whose liberal campaign promises were followed by highly conservative economic moves designed to suppress inflation, which was estimated to be 7,650% in 1990 (*New York Times*, 14 January 1991).

Although controlling inflation is an essential first step, the Peruvian crisis is so profound and multifaceted that it resists description and probably defies solution. Any solution must address the 80% urban unemployment rate, feed the 30% of the population dependent on emergency food supplies for survival, reduce an infant mortality rate that ranges up to 275 per 1,000 (Bonner 1988), make it economically viable for coca-growing farmers to switch to other crops, reducing a cocaine traffic estimated at 1.5 billion dollars (U.S.) in 1990 (*New York Times*, 14 January 1991), restore security, provide real government services to neglected Andean regions, repay the crippling foreign debt, and make massive investments of funds to stimulate the economy. Even the likelihood of progress in any one of these problem areas over the short term seems slim.

Unfortunately, if the larger problems cannot be solved, it is unlikely that those of the guano birds and their islands can be solved either. The ecological crisis of Peru's coastal ecosystem is aggravated by Peru's larger crisis of economic and governmental collapse. Existing pressures for protein and foreign export will continue to 'force' the use of management strategies that may not always be in the best long-term interests of the country, but are a short-term necessity. Successful management of coastal resources will include a broadening of the forms of exploitation, away from an excessive, sequential reliance on a single fish species, so that the economy is buffered against changes in particular resources. This will require state-limitation of exploitation of various resources such as purse-seining, and encouragement of other forms of exploitation such as tourism and guano harvesting. Regrettably, Peru's economic problems and resulting political instability make it difficult to establish a national consensus and to chart a stable management strategy.

NATURE OF THE MANAGEMENT TASK

The economic and political realities of present-day Peru make traditional conservation efforts irrelevant or at best ineffective. Conservation plans, especially by outsiders, would seem to be mere paper exercises. However, there are a number of things that can be done, both to lessen the damage during the present and to sow the seeds for future solutions on the coast.

What can be done

As in so many cases in developing nations, and in Latin America in particular, the problems are not ecological, rather they are social. Peruvian scientists do not need advice on managing their birds; their marine sciences are well developed (Zuta and Flores 1980). Peruvians developed methods that proved their worth in the sustainable harvest of guano while North Americans and Europeans were still market hunting or indulging in the plume trade (Doughty 1975). In fact, Peruvian managers of renewable resources have a great deal to teach us.

Nevertheless, they need our help. Peruvian scientists have minimal resources that must be stretched from the beleagured rainforests of Peru to the guano islands of the coast. They face assassination or murder by guerrillas and drug lords. Their study sites are often reached on roads that are 'near-death' experi-

ences. They have little access to books (Cooley and Golley 1989) and certainly cannot afford to subscribe to foreign scientific journals, some costing more than a biologist's annual salary (Duffy and Cooley 1990). Many Peruvian professionals, even university professors, earn as little as US$50 a month (Guillermoprieto 1990); many more are perennial students who earn only a few dollars from a variety of jobs to be able to continue their work. Such a lifestyle is common among biologists in Latin America from Tierra del Fuego to Mexico, but few have incomes and a standard of living as low as do Peruvians.

The most important goal of the international community may be to help ensure that Peru retains its resource managers and biologists, by supporting them through journal exchanges, book donations, travel support, fellowships, and cooperative projects (Pearson 1985, Cooley and Golley 1989, Duffy 1989a). We can also pressure international aid organizations, such as the World Bank and the Bank for International Development, and bilateral aid bodies such as the U.S. Agency for International Development, to employ Peruvians, especially younger ones, as consultants on projects. That should be done rather than continuing the present practice of relying on 'quickie visits' from Northern Hemisphere 'experts' to assess problems and recommend solutions (Duffy 1989b). A consultant's fee for one month of work in Peru could support a Peruvian biologist for one year or more. Over time, such investments in skilled residents will produce far more meaningful and longlasting results for science and development than could be produced by foreign consultants.

We can also support the conservation of Peru's resources by visiting them as tourists. The typical tourist route emphasizes Cuzco and Macchu Pichu in the Andes, but the Paracas and Nazca regions, with their mixture of ruins, earth lines, and guano islands are also visited. Only a single boat goes to the Ballestas Islands off Paracas, but there are a number of other islands that are equally interesting to visit, such as the Chinchas, Isla San Gallan and Isla La Vieja, as well as whale and seabird watching at sea. Given the strong Peruvian entrepenurial trait, such destinations would soon be exploited if demanded by tourists and associated conservation groups.

Unfortunately, the increasing possibility of terrorist activity in Peru restricts visits to those regions considered safe. The situation is likely to deteriorate still further over the short term, so expansion of the 'nature tourism' industry may have to await the return of more stable political conditions.

The Peruvian islands and headlands are presently managed by PESCA PERU, except for Punta San Juan. At Punta San Juan, a private group headed by Dr Patricia Majluf of Cayetano University, has organized a protective wardening system and the maintenance of the point's infrastructure to protect a breeding colony of the threatened Humboldt Penguin and a major group of fur seals (Patricia Majluf unpubl.). Given the government's lack of resources, such private efforts may be the best way to manage and protect many guano islands and biologically significant sites. Financing might come from a careful, Galapagos-style tourism where visitors are confined to paths or view the birds from blinds or hides. Unfortunately, formal control of San Juan has remained with the government which has continued to exploit the guano on the headland, causing considerable disturbance to breeding Humboldt Penguins, which nest in winter, the normal period for guano harvesting.

Leaving the guano unharvested would provide substrate for burrowing penguins and other seabirds which could then be used to attract tourists. This means that over the longer term guano may be more valuable to both the local and national economies on the ground than harvested. Punta San Juan is an important experiment or pilot project for the development of such management. Fortunately the proposed project has received support from international sources, such as the Noyes Foundation and Wildlife Conservation International, support that is essential to obtain governmental agreement.

Finally, guano is a powerful organic fertilizer that is already widely sold in Germany (6.95DM or US$4.50 per kg). Imported guano is 'cut' or diluted with the less rich guano of domestic chickens before being sold to consumers. Most or all of the guano on sale in Germany comes from Namibia, although some imports have come from Peru in the past (O. Leo Farje pers. comm.). Given European and North American interests in natural 'chemical-free' gardening, the future market for Peruvian guano could approach that of the nineteenth century. Presently, only limited marketing has been done and exports have been erratic (Zuta and Flores 1980). Part of the problem may be related to reduced supplies following El Niño. Nevertheless, if Northern Hemisphere gardeners were to begin demanding guano, this might form the best and least demanding aid that developed nations can give to Peruvian seabirds.

CONCLUSIONS

Competition with a commercial fishery and political changes, most far removed from the Peruvian upwelling ecosystem, have led to a bird community that is a frail shadow of what it was before the 1960s. The clearest lesson from all this may be that biological and conservation measures, no matter how rational and scientifically justified, may play little role in management decisions concerning seabirds, com-

pared with economic and political forces. Effective conservation will take political and economical realities into consideration, either working around them or contributing to their removal. In terms of Peruvian seabirds, we can either save fragments of the ecosystem or we can work toward an exploitation of the Peruvian upwelling ecosystem that places importance on birds. The former may represent only 'rearranging deckchairs on the *Titanic*', while the latter is part of a larger solution of which seabirds are only a very small part. Although the situation is not a promising one, the many young Peruvian biologists and conservationists offer us the hope that if something can be done, they will try to do it. We owe them our support and gratitude.

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