VERTEBRATE PEST PROBLEMS RELATED TO AGRICULTURAL PRODUCTION AND APPLIED RESEARCH IN ARGENTINA

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ABSTRACT

A number of vertebrate pests have been recognized in Argentina, either as competitors with livestock or as consumers of crops or other agricultural products. National and provincial laws have declared many species as pests, permitting control by almost any means. However, few of the species have been sufficiently investigated, particularly with respect to the actual economic damage they inflict. In recent years, research is shifting from general descriptive studies of some of these species to attempts to quantify their damage, reevaluate their pest status, evaluate control techniques, and determine management options. The discipline of wildlife/vertebrate pest management seems to be emerging, both within the government and university systems.

KEY WORDS: agriculture, applied research, Argentina, control, damage, historical review, livestock, needs, trends, vertebrate pests

RESUMEN

Varios vertebrados han sido reconocidos como plagas en Argentina, tanto como competidores con el ganado como consumidores de cultivos u otros productos agrícolas. Leyes nacionales y provinciales han declarado varias especies como plagas. De acuerdo con estas leyes, el control de dichas especies puede ser realizado por casi cualquier medio. No obstante, pocas de estas especies han sido investigadas suficientemente, en particular con respecto al daño que causan. Recientemente, la investigación se ha modificado desde estudios de descripción general de estas especies, a tentativas de cuantificar el daño, re-evaluar su papel como plagas, evaluar las técnicas de control y determinar sus opciones de manejo. La disciplina de manejo de vida silvestre/vertebrados plaga parece estar surgiendo tanto en el gobierno como en las universidades.

PALABRAS CLAVES: agricultura, Argentina, control, daños, ganadería, investigación agrícola, necesidades, tendencias, plagas vertebrados, repaso histórico

RESUMO

Raconhecem-se vários vertebrados praga na Argentina, tanto os que competem com o gado, como consumidores de cultivos ou outros produtos agrícolas. As leis nacionais e provinciais declararam muitas espécies como pragas, permitindo o seu controle por quase qualquer meio. Entretanto, poucas espécies têm sido suficientemente pesquisadas, particularmente com respeito ao dano econômico que elas causam. Em anos recentes, a pesquisa tem mudado de estudo gerais descritivos a tentativas de quantificar o dano, reavaliar o seu status de praga, avaliar técnicas de controle e determinar opções de manejo. A disciplina de manejo de fauna silvestre/controle de pragas parece estar emergindo, tanto dentro do governo como nas universidades.

PALAVRAS CHAVE: agricultura, Argentina, controle, danos, gado, necessidades, pesquisa aplicada, pragas vertebradas, revisão histórica, tendências

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Except for the European rabbit (*Oryctolagus cuniculus*), European hare (*Lepus europaeus*), eared dove (*Zenaida auriculata*), and monk parakeet (*Myiopsitta monachus*), very little information currently exists on many of the other species considered pests of agriculture and livestock production in Argentina. Nonetheless, considerably more information is now available than existed one to two decades ago when Bucher (1970) and Murton *et al.* (1974) documented eared doves as a pest of cereal crops. Amaya (1981) described the research status for the main Patagonian vertebrate species considered pests or competitors for forage with sheep: the European rabbit, the European hare, the red fox (*Dusicyon culpaeus*), the upland goose (*Chloephaga picta*), and the guanaco (*Lama guanicöe*); and Jackson (1984) summarized the important roles played by vertebrate wildlife in Argentina's economy. In this paper, we describe the current status of vertebrate pest problems related to agricultural production in Argentina. A map indicating provinces is included for reference (Fig. 1).

EUROPEAN RABBITS AND HARES

The status of the European rabbit has been reviewed by Amaya (1981), Howard and Amaya (1975), Jackson (1983),

and more recently Bonino (1986*a*,*b*). The European rabbit is thought to have arrived into Neuquén Province from Chile between 1945 and 1950 (Howard and Amaya 1975). In 1981 it occupied about 35,000 km^2 in Neuquén and Mendoza Provinces. It also was introduced into Tierra del Fuego, apparently on two separate occasions—in about 1936 and 1950—and in 1981 was thought to occupy 12,500 km^2 (Amaya 1981). Bonino and Gader (1987) reported additional range expansion north to about Malarque in Mendoza Province and eastward expansion along the Colorado, Neuquén, and Picún Leufú Rivers in Neuquén Province where it is now estimated to inhabit 50,000 km^2.

Concern about this animal has resulted from its direct competition with domestic animals for forage pasturelands, its damage to forestry, orchard plantations (Amaya 1981, Bonino 1987), and agricultural crops, as well as its impact on soil erosion, irrigation channels, and livestock and wool production. Amaya (1981) reported that these 1.75 kg rabbits eat about 7.2% of their body weight daily, or about 128 g in dry forage/day; 45 kg sheep eat only 2% of their weight daily or about 900 g of forage/day. Jackson (1983) also referred to ranchers describing loss of entire crops of alfalfa, corn, and clover; reduction in birth rates of sheep and decline in wool production; and deteriorating rangelands during periods of rabbit population outbreaks, such as occurred in 1982 and 1983. Jackson (1983) visited Argentina amid reports of 100 rabbits/ha throughout 41,000 ha of Neuquén Province. Densities of 83–114 and 39–70 rabbits/ha have been described for areas in Neuquén and Tierra del Fuego Provinces, respectively (Amaya and Bonino 1981).

The European hare was introduced into Argentina, perhaps around 1888, and has spread throughout the country (Grigera and Rapoport 1983). However, it does not form aggregations and is not considered a pest by ranchers (Jackson 1983). It also is regarded as a valuable resource for hunting and for exporting meat. Hare meat accounted for 99.7% of all prepared meat products exported from Argentina (valued at $89 million) between 1976 and 1979 (Mares and Ojeda 1984).

Bonino (1987) indicated that the only control techniques for rabbits used in Argentina involve the myxomatosis virus and toxic baits, but concerns exist regarding their use. Bonino (1987) has suggested that if rabbits are to be stopped from advancing their range, they need to be viewed as a chronic, not an irruptive, problem. Both Howard (1972) and Jackson (1983) have provided recommendations for research, training, and control for the European rabbit problem. Yet at present, no plan for dealing with rabbit populations and their potential outbreaks is in effect.

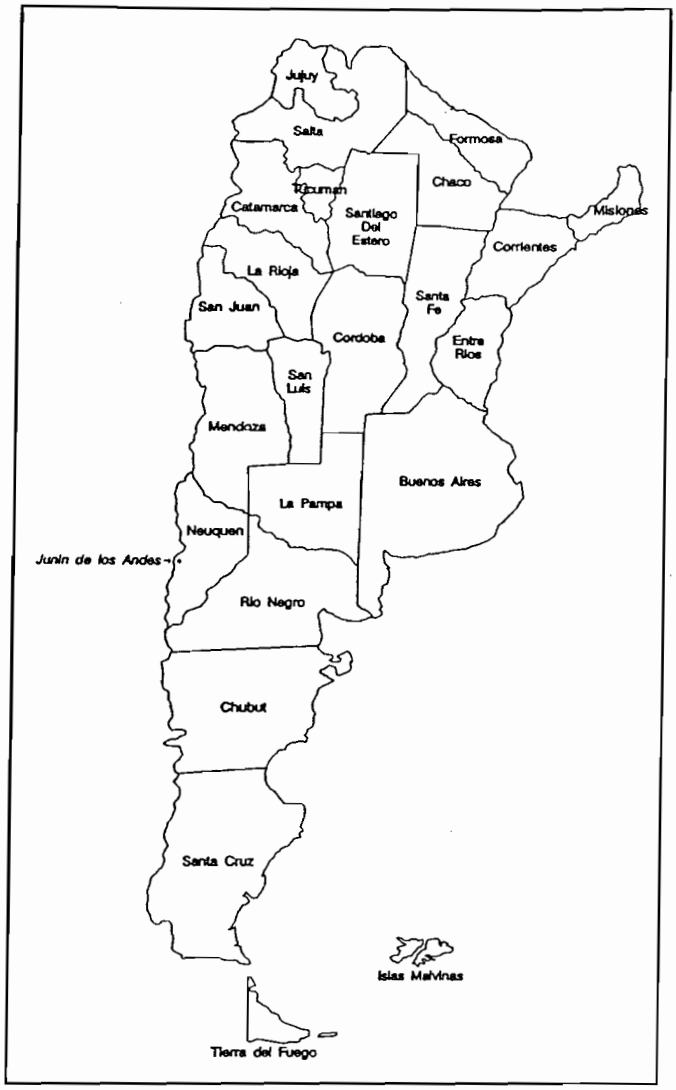

Figure 1. Map of Argentina indicating location of provinces.

RODENTS

In their overview of rodent problems in Latin America, Elias and Fall (1988) stated that rodent problems throughout the region are similar to those in other areas of the world: disease transmission, food destruction, reduced timber and forage production, and physical damage. However, in their list of 119 citations, only four referenced rodent problems in Argentina; two related to rodents involved in transmission of Chagas' disease (Bucher and Schofield 1981) and Argentine hemorrhagic fever—Junin virus among primarily wheat and cornfield workers (Gratz 1984, Kravetz 1978), and two related to sugarcane damage (Massoia 1971, 1974). Similarly, of 202 references to rodent studies in Argentina, out of 1,742 listed for Latin America (Mitchell *et al.* 1989), only four or five referred to rodent damage situations. Except for occasional damage related to periodic outbreaks, only the taxonomy, distribution, and public and domestic animal health aspects of rodents have received much research attention (Anonymous 1978, Busch *et al.*

1984). Rodent damage to agriculture in Argentina is either not sufficiently serious (except during outbreaks) to warrant research or not of interest to many scientists.

The main rodent species of concern to agriculture in Argentina are members of the suborders Myomorpha (Family Cricetidae) and Caviomorpha (Families Centomyidae and Caviidae). In the Cricetidae, species of the genera *Oryzomys* and *Holochilus* (Quintanilla *et al.* 1973) are considered the most important; *Octodon, Akodon*, as well as *Rattus* and *Mus*, found throughout the world, are also mentioned (Elias and Fall 1988). The densities of these species in some crops have been investigated, but not relative to damage (de Villafañe *et al.* 1973, Kravetz and de Villafañe 1981, Kravetz and Polop 1983, Manjon *et al.* 1983).

Anonymous (1978) reported that in 1948, 1% of all grain produced in Argentina was consumed by rodents, which in 1976–1977 extrapolated to about 288,190 tons of agricultural production. However, little specific information on actual losses or the pest status of these rodents is available.

The marsh rat (*Holochilus brasiliensis*) is considered to be the most important crop pest, causing damage to such crops as sugarcane, rice, bananas, vegetables, and melons along the main agricultural river systems in northwest and northeast Argentina (Massoia 1974). In Jujuy Province of northwest Argentina, he described a population outbreak of marsh rats in October 1974 that resulted in population densities of between 300 and 900 rats per/ha and losses to sugarcane of 22,400 tons. In the Paraná River delta, Gurini (1986) reported that marsh rats damaged willow and pine plantations, inflicting as much as 50% damage during the first critical year of planting; normal losses at that time are usually 15% (Toscani and Mujica 1978). *Oryzomys* spp. and, to a lesser extent, *Calomys* spp. and *Akodon* spp. also reportedly cause preharvest and postharvest damage to cereals (Quintanilla *et al.* 1973).

Several members of the suborder Caviomorpha have been directly implicated in crop damage as well as rangeland and soil destruction. Contreras (1973) summarized the damage implications of the "tuco-tuco" (*Ctenomys* spp.; Family Ctenomyidae), a fossorial rodent in Argentina. Natural grassland vegetation is supplemented by sugarcane, manioc, maize, potatoes, and roots of fruit and pine trees. Quintanilla *et al.* (1973) indicated that the species is responsible for erosion damage to fields, dikes, and roadsides due to their extensive (15- to 100-m diameter) burrow systems. Control has consisted of mechanical destruction of burrows, removal of animals, and use of toxic baits, and burrow fumigation.

The designation of the vizcacha (*Lagostomus maximus*, Family Chinchillidae) as a pest or resource is often debated (Jackson 1986, 1989). Vizcachas are colonial, nocturnal herbivores that feed on a variety of cultivated and wild vegetation around their burrow systems; 40–50 animals weighing between 2 and 8 kg can occupy a colony with up to 100 burrow openings (Branch and Villarreal 1988). The vizcacha has been designated a national pest due to its competition for pasturelands with livestock, its consumption of seeded pastures and cultivated crops, and its degradation of soils. Sixteen vizcachas are reportedly able to consume the equivalent amount of forage as two sheep (Jackson 1986). This animal, however, is also valued for its fur, skin, and meat, and is a popular small game animal for sport hunters. Over 371,000 skins were exported between 1976 and 1979, representing a value of US$1.2 million (Mares and Ojeda 1984). Vizcacha meat is sold within Argentina, either fresh or preserved in jars (Jackson 1986).

A number of the same techniques used to control "tuco-tuco" are also employed against vizcachas. Despite massive campaigns to eliminate the vizcacha in the 1940's and 1950's, it is still abundant in Argentina and has expanded its range in agricultural zones (Jackson 1986). However, in arid regions, such as Lihue Calel National Park in La Pampa Province, some local populations have disappeared, probably due to combined effect of vegetation dynamics and climatic factors (Branch and Villarreal 1988). Although a considerable amount of research to understand vizcacha biology currently is being conducted in Argentina (Branch and Fowler 1993, Branch, this number), little if any effort is being devoted to determining the economical justification for its pest status. The vizcacha may be an example of an animal for which a sustainable harvest program for meat and pelts would be beneficial (Jackson 1989, Zaccagnini and Venturino 1993).

PREDATORS

Pumas.- Research on the puma (*Felis concolor*) in Argentina is only beginning. Most information on its presumed status as an important predator of domestic livestock is based on rancher testimonies and surveys. Pumas are considered important predators to cattle, sheep, and goats in Upper Córdoba, La Rioja, and Catamarca Provinces, but more importantly in La Pampa, Neuquén, eastern Río Negro, Chubut and Santa Cruz Provinces (J. von Thungen, Fauna Silvestre, INTA, Bariloche CC277, 8400 San Carlos de Bariloche, Río Negro, Argentina, pers. comm.; Bellati 1987, 1992*a*). Pumas once ranged throughout the Argentine Patagonia (Olrog and Lucero 1981), which extends across about 800,000 km^2 of several of these southern provinces (Bellati and von Thungen 1990). Sheep ranching is now widespread in Patagonia, and pumas have been extirpated from many areas (Novaro 1991). Pumas normally feed on rats, armadillo, quail (von Thungen 1987), and the plains vizcacha (Branch and Fowler 1993).

Dayenoff (1987) studied the impact of pumas on the livestock of ranchers in La Rioja Province. Eighty percent

of 50 ranchers surveyed indicated that pumas were a problem to their livestock. Annual losses of between 20%–25% to goats and 4%–12% to cattle were estimated, representing about 28 goats and 9 cattle per ranch. A survey in 1990–1991 of many of the same ranchers (O. Bazan, Instituto Nacional de Tecnología Agropecuaria, La Rioja, Apartado 50, Chamical, Argentina, pers. comm.) indicated that as many as 27% of the goats and 5% of the cattle could be lost to pumas annually. This represented about 18 goats, based on an average of about 70 goats per rancher—or a maximum of about US$400 per year. In both surveys, losses to adult animals were greatest between May and November, and losses of kid goats peaked between January and April.

Pumas have traditionally posed problems to livestock production in southeastern Buenos Aires, eastern Río Negro, Chubut, and Santa Cruz Provinces (Bellati 1992*b*). However, they recently are being implicated in damage situations in central and southern Neuquén and western Río Negro Provinces. In Río Negro Province, 17% of 221 livestock producers indicated that pumas presented a problem at their ranches, and many producers felt that these problems were increasing (Bellati 1992*a*). In western Santa Cruz Province, pumas were considered the cause of death to 23% of perinatal sheep and implicated with foxes in the death of 30% of all lamb mortality (Quintas and Layana 1982).

Exploitation for fur and control of pumas usually is undertaken by professional hunters using shooting or trapping techniques. In La Rioja Province, ranchers or hired hunters kill an average of nine pumas per year (Dayenoff 1987). Although the international trade in puma skins has never been high, totaling only 3,538 skins during peak years of 1976–1979 (Mares and Ojeda 1984), skins were available in local communities; and in Neuquén Province, they sold for US$25 each in February 1993 (R. Bruggers, pers. obser.).

Foxes.- Considerably more information is available on fox depredation situations. Fox research has centered in Patagonia. Several species of *Dusicyon* exist in Argentina, and the red fox (*D. culpaeus*) is the species most implicated with predation and most studied. With the exception of some preliminary research on bait stations as a censusing technique (von Thungen 1991*a*), no attempts exist to estimate overall population densities for management purposes (Novaro 1991). Research has centered on reproductive biology, food habits, and control methods.

Crespo and De Carlo (1963) studied foxes in southern Neuquén Province and found that their diet, based on stomach contents, consisted of 36% hare, 22% sheep, and 32% rodents. Novaro (1991) estimated fox densities in southern Neuquén Province of 0.11–0.20 foxes/ha on hunted ranches and twice that on nonhunted ranches. He characterized foxes as selective hare predators that switch to other prey when hares become scarce. He found that in 1989 and 1990 fox diet (by volume) included 74% and 43% hare, 12% and 34% sheep, and 4% and 13% small vertebrates, respectively. When hare density decreased, as in 1990, male foxes consumed more sheep, and female foxes consumed more rodents. However, he also considered his sheep predation estimates excessive because they included consumption of sheep carrion.

Bellati and von Thungen (1990) described the red fox as the main lamb predator on Patagonian ranches. Between 1979 and 1986, they examined 1,717 lamb carcasses at seven ranches. Predation was considered the cause of death for 4.7%–21.6% of 1,629 perinatal (1–7 day old) lambs; exposure/starvation was the main cause. At two Río Negro ranches, 43.4% of eighty-eight 7- to 60-day-old lambs died from fox predation; exposure/starvation again was the other most important cause of death. Over 50% of 221 ranchers in Río Negro Province have problems with foxes, and 78% feel that these problems are increasing (Bellati 1992*a*). This survey did not indicate much difference between predation rates on private fields (55% of 109 fields) and public fields (64% of 50 fields). However, the number of sheep per field may influence their susceptibility to predation: predation occurred in 92% of 13 fields that held between 2,000 and 4,999 sheep and in 46%–64% of 146 other fields that held between either 20 and 1,999 or more than 5,000 sheep.

In the puma survey conducted by Dayenoff (1987) in La Rioja Province, ranchers also indicated that foxes were goat predators. Six of the 50 ranchers surveyed, hunt or permit hunting on their ranches with as many as 40 foxes killed per year on a particular ranch.

The red fox is not often mentioned in laws and regulations as a pest. Nonetheless, Patagonian ranchers try to reduce fox predation using such methods as trapping, denning, toxicants, dogs, shooting, and compensation payments. Indiscriminate use of toxicants was banned in 1990 (Bellati 1992*b*). Trapping and shooting apparently are now the most commonly used techniques. The actual value of shooting and trapping foxes relative to livestock protection has not been evaluated.

Guard dogs have been used to protect sheep in Argentina. Although systematic investigation of their effectiveness was not included in the original introduction of four border collies from the United States in 1990, three of the original dogs and four of their puppies are still working; others have become household pets, been killed for eating sheep, been shot in flocks by ranchers not aware of their purpose, or simply have not been trained (J. von Thungen, Fauna Silvestre, Instituto Nacional de Tecnología Agropecuaria, Bariloche CC277, 8400 San Carlos de Bariloche, Río Negro, Argentina, pers. comm.). Von Thungen (1991*b*) determined that use of guard dogs costs about US$1,500 the

first year and about US$400 each succeeding year and that dogs could provide a cost-effective, alternative method for reducing predation losses. No investigations have been initiated in Argentina to evaluate use of llamas as sheep guards; these animals are being increasingly promoted in the United States in this capacity (Franklin and Powell 1993).

Since 1990, Bellati (1992*b*) has been actively evaluating operational field use of the Livestock Protection Collar (LPC) in Patagonia. The LPC containing the toxicant 1080 is available for use by certified applicators (Connolly 1993) in some areas of the United States. The LPC is not yet registered for use in Argentina, but apparently is available at a cost of US$25 per collar with 1,300 in use in Santa Cruz Province and another 3,000 in the rest of Patagonia (J. P. Bellati, Fauna Silvestre, Instituto Nacional de Tecnología Agropecuaria, Bariloche CC277, 8400 San Carlos de Bariloche, Río Negro, Argentina, pers. comm.). Descriptions of its use vary, but apparently as many as 50 lambs are fitted with LPC's and placed with flocks of up to 350 other sheep in paddocks experiencing losses. On ranches where "control" use has been monitored, J. Bellati (pers. comm.) reports a consistent reduction in losses of sheep to foxes. However, J. Bellati (pers. comm.) also mentioned increased puma problems on these same ranches during the past 3 years. It is interesting to speculate that pumas may have been a predator or dispersal agent of foxes, and/or they are now moving into areas previously occupied by foxes. Pumas are known to prey on smaller carnivores such as coyotes, *Canis latrans*, (Young and Goldman 1946), and larger canids are known to exclude the next smaller ones (Sargeant and Sovada 1993). Bellati (1992b) considers that to reduce livestock losses to predators, research into damage control methods needs to be intensified, new systems of selective control need to be implemented and legalized, and groups of individuals dedicated to controlling predators need to be established.

BIRDS

Although Bucher (1984) and Bucher and Bedano (1979) listed more than 20 species of birds considered as pests to grain, fruit or vegetable crops, livestock, fish hatcheries, aircraft, and urban situations, only four of these species are considered of particular agricultural concern in Argentina: the eared dove, the picazuro pigeon (*Columba picazuro*), the spot-winged pigeon (*C. maculosa*), and the monk parakeet. More recently, chestnut-capped blackbirds (*Agelaius ruficapillus*) and waterfowl (*Dendrocygna* spp. and *Netta peposaca*) are becoming implicated in crop damage, in particular to sprouting and ripening rice (Zaccagnini and Venturino 1992, 1993; Zaccagnini *et al.* 1992).

Doves.- Eared doves inhabit mosaic pattern landscapes of thornbush and croplands (Bucher 1970) throughout the main agricultural areas of northern Argentina. Doves form communal breeding and roosting aggregations along rivers and in woodlands (Bucher 1990, Murton *et al.* 1974). Breeding colonies of up to several million birds have been documented in Córdoba and Entre Rios Provinces in Argentina and in Uruguay (Bucher 1990). Although information on local and migratory movements is scarce, it is thought that doves forage from 60 to 100 km from their roosts (Bucher 1970, 1974, 1990) and possibly migrate distances of more than 500 km between Argentina and northeastern Brazil (Bucher 1992*a*).

The natural diet of eared doves was described by Murton *et al.* (1974) as small, annual seeds collected from the ground. These authors also reported that the diet of doves was changing to seeds of cultivated plants, such as sorghum, wheat, millet, and to a lesser degree corn, peanuts, and sunflowers. Eared doves are considered both national and provincial pests in Argentina primarily because of their damage to sunflower, wheat, and sorghum. As a result, they are now frequently controlled by individual farmers using grain baits poisoned with toxicants such as parathion, endrin, dimethoate, chlorpyrifos, and others. This practice is discouraged because of its indiscriminate effects on a variety of nontarget birds that feed directly on the baits, as well as several species of raptors that feed on poisoned carcasses (Zaccagnini and Venturino 1993).

Because of their abundance and classification as a pest, doves also are an important hunting resource to Argentina. Several outfitters provide opportunities to hunters from Argentina, neighboring countries, the United States, and Europe. Individuals pay US$2,000–$3,000 to shoot an unlimited number of doves in breeding or roosting colonies for several consecutive days. However, doves are not managed as a sustainable resource, as no shooting regulations currently exist. While such shooting does not visibly appear to have impacted dove numbers in the three major roosts around Paraná in Entre Rios Province (M. Zaccagnini, pers. obser.), Bucher (1990) reported that dove numbers in some areas seem to have decreased considerably during the past decade, possibly due to a decrease in areas sown to sorghum and other preferred grains.

Pigeons.- The population dynamics and agricultural impact of spot-winged pigeons and picazuro pigeons have not been well-documented (Bucher 1992*a*, Zaccagnini and Bucher 1987). They are found in many areas of northern Argentina (Goodwin 1983) and seem to increase in numbers when suitable habitats are created by replacing forests with agriculture (Willis and Oniki 1987). This has resulted in range expansion in the Entre Rios Province (M. Zaccagnini, pers. obser.) and Córdoba Province (Bucher 1992*a*). Although spot-winged pigeons feed on ripening sorghum for 2–3 months of the year, their main food items come from stubble, unharvested fields, or forage sorghum; they also are reported to damage alfalfa and clover year-round,

sprouting soybeans in December, and sunflower cotyledons in September (Zaccagnini and Bucher 1987). Picazuro pigeons have similar foraging habits, taking much food from stubble or fallow fields, and damaging emergent sunflowers and soybeans (Bucher 1992*a*). Both species can be seen feeding together in small flocks. Spot-winged pigeons are officially considered pests in some provinces, such as Entre Rios. As with eared doves, farmers implement control on their farms using toxic baits, generally during the time sunflower and soybean plants emerge, with the idea of eliminating those individuals actually causing damage (Bucher 1992*a*). This can result in considerable nontarget mortality to birds such as eared doves, picui ground doves (*Columbina picui*), and others that receive direct poisoning, as well as to raptors that receive secondary exposure (M. Zaccagnini, pers. obser.).

Waterfowl in southern Argentina.- In extreme southern Argentina, sheldgeese also are considered legal pests. The upland goose, ashy-headed goose (*C. poliocephala*) and the ruddy-headed goose (*C. rubidiceps*) breed in Tierra del Fuego and Santa Cruz Province between October and March and winter in southern Buenos Aires and eastern La Pampas and Río Negro Provinces between April and September (Martin 1984). The upland goose was declared a national pest in 1931 because of its perceived competition with domestic livestock for forage in its breeding area and its impact on agricultural crops such as autumn-sown cereal (e.g., wheat, white clover, rye, and fescue) and grass pastures, as well as stubble, in its wintering area. Densities in these areas vary between 1.2 and 3.5 geese/ha on wheat fields less than 25 days old and 0.5 to 3.5 geese/ha in those more than 25 days old (Martin *et al.* 1986). Flocks of 500–1,000 geese/field have been observed.

Research has not been conducted to evaluate methods for reducing losses. However, a number of techniques have been tried to minimize agricultural impact of this species, including collecting eggs (180,000 from 25,000 nests in 1972–1974), hazing with aircraft, promoting hunting by permitting a daily limit of 20 individuals, recommending changes in agricultural practices, and initiating monetary compensation programs for losses. Its value as a renewable resource for hunting is now being recognized as important (Martin 1986), and many hunting companies now exploit geese as a resource in Patagonia.

Waterfowl and blackbirds in northern Argentina.- Farmers in selected areas of Entre Rios, Santa Fé, and Corrientes Provinces have begun expressing concern over damage by waterfowl and blackbirds to rice schemes. A number of species of waterfowl and the chestnut-capped blackbird are considered pests. In most situations, rice in this region is grown on large private ranches or farms. The main rice producing areas are along the Paraná River in Entre Rios, Santa Fe, and Corrientes Provinces. About 120,000 ha are currently under rice cultivation in these provinces. Rice growers continue to use poison baits in fields to kill what they perceive as depredating birds. At San Joaquin in 1991, this practice resulted in considerable nontarget bird mortality (Zaccagnini and Mathern 1991).

Research on waterfowl numbers, damage to rice, farmer attitudes, control methods, and hunter shooting success in and around rice fields in the Santa Fe Province were begun in 1991 (Zaccagnini and Venturino 1992). It was found that: a) although 18 species of waterfowl exist in the three province areas, only one or two species damage rice; b) over 100 species of other birds are directly in or very closely associated with rice-field agriculture; c) waterfowl hunting generates considerable sums of money for commercial hunting companies that attract both Argentines and foreigners (principally North Americans); d) rice producers in the study areas perceive waterfowl as pests and, in some cases, control them with poisoned grain baits; e) although provincial hunting regulations exist, they vary among the three provinces from permitting shooting 20 birds/day of only three species in Santa Fe to 30 birds/day of any species in Corrientes; and f) little information is known on the biology, reproduction, population numbers, and movement patterns of any of the 18 species in Argentina.

Zaccagnini and Venturino (1992) proposed that the eventual resolution of this very complex situation will be based on identifying waterfowl as a sustainable resource to benefit all parties. They envision: a) development of rational hunting quotas based on data obtained on waterfowl productivity and movement patterns; b) education of outfitters as to the value of a sustainable approach to hunting to assure the availability of this resource in the future; c) possible introduction of loss compensation programs to farmers, perhaps from hunting revenues; and d) elimination of indiscriminate poisoning through farmer education programs showing the economic value of waterfowl relative to the minimal losses they cause to rice.

Chestnut-capped blackbirds have been documented in wetlands associated with rice production areas for many years (Pergolani de Costa 1950). This association has been particularly noticeable along the Paraná River between Corrientes and Santa Fe Provinces. However, neither the basic biology nor the relationship of the species to rice cultivation has been studied until recently. In Santa Fe Province, Chestnut-capped blackbirds established nesting colonies along or close to the borders of rice fields in 1991–92 and 1992–93 (Zaccagnini *et al.* 1992, M. Zaccagnini, pers. obser.). One, approximately 0.125-ha colony, adjacent to one 45-ha rice field in a 250-ha rice production area, contained 330 nests in 1991–1992 and 350 nests in 1992–1993. In addition, a large number of nonnesting birds were present in and around the rice farm. In February 1993, when the population was at its peak, C. J.

Feare (Central Science Laboratory, Ministry of Agriculture, Fisheries and Food, Tangley Place, Worplesdon, Surrey GU3 3LQ, United Kingdom, pers. comm.) estimated approximately 40,000 birds exiting an adjacent rice-field roost. Although rice was part of their diet, which also included wild seeds and insects (M. Zaccagnini, pers. obser.), in both years almost all birds basically dispersed and stopped using the rice field about 3 weeks after breeding ended when nearly all the rice was about to be harvested. Flocks of 200–300 birds were, however, seen feeding in mature rice fields along the Paraná River in late March 1993 (R. Bruggers, pers. obser.).

The area cultivated to rice in Santa Fe Province has increased from about 7,000 ha in 1988–89 to about 9,000 ha in 1992–93, and from about 107,000 ha to 128,000 in the three provinces during the same time period (Secretary of Agriculture, Livestock and Fisheries annual statistics). Feare (1991) and Clark (1991) suggested that if rice production in the area continues to expand and if annual blackbird population trends continue to increase, blackbirds could eventually pose a serious threat to rice growers with small, isolated holdings. However, this situation needs to be investigated to determine the actual vs. perceived impact of this species on rice production in the region and the timing of damage. If damage occurs only for a short period during breeding and birds are also harvesting many insects, or if damage occurs to rice harvested late in the season, the overall impact of blackbirds may not be as great as originally thought.

Parakeets.- Monk parakeets are also found throughout northern Argentina (Bucher and Bedano 1979, Bucher *et al.* 1990). They originally nested in natural woodlands, but have extended their range into associations of intensive agriculture with introduction of eucalyptus plantations (Bucher 1992*a*). Monk parakeets form flocks of a few to several hundred individuals. They damage standing corn, sunflower, and sorghum, as well as fruit such as pears and peaches (Bucher *et al.* 1990).

A combination of biological, ecological, and behaviorial factors make the monk parakeet very susceptible to lethal control techniques (Bucher 1992*a*). Monk parakeets are controlled by plant protection departments within some provincial governments, and affected farmers are assessed the costs. Usually a pesticide like carbofuran is mixed with petroleum grease and applied to the nest opening using an elaborate system of pulleys and brushes. However, because a number of other bird species use monk parakeet nests (Aramburu 1990*a,b*; Martella and Bucher 1984), direct and indirect poisonings of nontarget species is a concern. While this technique is effective and certainly capable of eliminating local groups of parakeets, alternative, more selective and environmentally safe replacement methods are being urged (Feare 1991, Jaeger 1991). Bucher (1992*a*) also noted that the level of damage needs to be sufficiently high before control campaigns should be considered. Clark (1991) further recommended that the entire method and the need to kill parakeets be reviewed regularly to assure that the practice does not continue simply as a tradition, rather than as a justifiable action.

Parrots.- In northwest Argentina, fruit growers consider parrots to be pests of citrus. In 1990, fruit production in the region was valued at US$43 million dollars and represented 54% of Argentina's overall fruit production (Sauad *et al.* 1991). A 1988 survey of fruit growers in Jujuy Province resulted in all respondents reporting parrots as pests (Cabezas 1988). The blue-fronted amazon (*Amazona aestiva*) is considered to be the main bird implicated, causing damage to grapefruit, lemons, and three varieties of oranges. This species and several others have also been declared national or provincial pests (Sauad *et al.* 1991).

Actual studies of damage by parrots to citrus are infrequent. Navarro *et al.* (1991) found less than 1% damage by blue-fronted amazons to orange, lemon, and grapefruit trees in 80 ha in northeast Tucuman Province and estimated the economic impact at only US$26/ha to the most severely damaged fruit—oranges. Sauad *et al.* (1991) sampled damage to fruit on trees and on the ground in northwest Argentina. They reported damage ranging from 0.27% grapefruit/tree to 1.87% oranges/tree, with additional damage to fruit on the ground. In extrapolating these losses to the specific production area and to the region as a whole, the authors estimated that damage levels reached US$37,000 and US$1.88 million, respectively. Because they observed distinct preferences by parrots for certain roosting vegetation within the citrus plantation as well as for certain varieties of oranges, they suggested that changes in cultural and cropping practices might help alleviate the problem.

Bucher (1992*b*) has claimed that the national and provincial pest status for this and other species of parrots in Argentina is unjustified and may ultimately threaten their existence. Under this status, parrots have been controlled by shooting, scaring, or capturing for the pet trade, the latter which apparently has had a significant impact on populations of some species such as blue-fronted amazons. Over 31,000 blue-fronted amazons were exported from Argentina between 1981 and 1989 (Bucher *et al.* 1992), and over 920,000 total parrots, 49% of the entire neotropical parrot trade, were exported from Argentina between 1982 and 1988; the United States, European Community, and Japan have been the largest importers (Thomsen and Mulliken 1992). Because trappers not only take all young from the cavity nest, but also cut down the nesting tree, the effects of this trade on parrot populations can be enormous.

Beissinger and Bucher (1992) argue that a conservative approach to sustained harvesting of parrots (harvesting part

of a brood, leaving the nesting tree, and giving them a market value) might lead to increased parrot production and habitat conservation. They caution that such an approach to parrot ranching must be based on information on the biology of the parrots, developed control techniques, site specific quotas, and enforced harvesting and trade regulations, most of which is currently lacking for all species of concern. This situation apparently is changing, as annual export quotas of between 4,000 and 24,000 have been established for each of several species, and the export of several other species has been banned altogether by Resolution 6/93, the CITES Management Authority of Argentina (Notification to the Parties No. 739 from the Secretariat of CITES, May 7, 1993, Lausanne, Switzerland).

CONCLUSIONS

Management of vertebrate pests is complicated by a need to know the economic importance of damage levels, the susceptibility of a species to control measures, and the agroecosystems where management is needed. With only a few exceptions, little essential information exists on which to develop vertebrate pest management (VPM) strategies in Argentina.

In this context, several themes stood out in our review of vertebrate pests in Argentina: a) the limited number of current Argentine scientists conducting research necessary to establish VPM programs; b) the paucity of research data for many species upon which to base management strategies; c) the long-term practice of national and provincial governments of declaring animals as pests irrespective of whether they are known to be responsible for economically valid levels of losses; d) the new, general trend to consider many pest species as renewable resources to be managed by sustainable harvesting; e) the emphasis by farmers, ranchers, control specialists, and politicians for techniques ("off the shelf" technology) for use in controlling pests; and f) the need for farmer/producer involvement with research organizations to develop and test applied approaches to solving particular problems.

Wildlife Scientists.- Vertebrate pest management is a specific expertise of wildlife management. Few professional wildlife/VPM specialists are presently working in Argentina. For example, government-sponsored VPM research is primarily conducted or coordinated by the Pest Management and/or Wildlife Subprogram based at the National Institute of Agriculture and Livestock Technology (INTA) Experimental Station in Paraná, Entre Rios. Only about five INTA research scientists at the Paraná and other INTA research stations in Argentina are directly involved in VPM research. Other related wildlife management concerns include pesticide impact assessments, biodiversity maintenance, and natural resource conservation. The need for more trained scientists in all these areas is critical. The initiation of a Master's degree program in wildlife management at the National University of Córdoba, Center of Applied Zoology, in 1992 in cooperation with INTA should be very helpful. The program also has recognized the importance of increasing its emphasis in applied areas such as VPM (E. Bucher, National University of Córdoba, Córdoba, Argentina, pers. comm.). However, more opportunities than currently exist need to be found in the research and management sectors for program graduates to apply their skills.

Wildlife research.- A long-term approach of defining a particular problem and the studies needed to develop a management strategy could be initiated for those species for which basic research has been conducted, such as the European rabbit, monk parakeet, and eared dove. Where and when crop protection methods are justified, they need to be clearly defined, prioritized, and studies identified that can lead to their resolution within the context of a management strategy. Developing efficient, economical, safe, and environmentally acceptable techniques for bird pest management can be very time-consuming and difficult. While crop protection techniques, such as repellents, resistant cultivars, chemosterilants, physical barriers, lure crops, selective avicides, and habitat alterations among others, are always needed "now," it is important to evaluate them relative to the biology, ecology, and behavior of the particular pest. Increased cooperation between the scientists of different organizations, with the involvement of the agricultural producers, could lead to development and testing of management strategies. This kind of collaborative initiative usually is highly productive, and it is especially important when research agendas differ and scientific expertise and other resources are limited.

Pest status declarations.- Despite the lack of scientifically based damage or loss data for many animals mentioned in this paper, they and other vertebrates that may have only occasional impact on food and fiber have been declared either national or provincial pests. Some are not even found in the provinces in which they are declared pests and, once declared, are very difficult to have removed (Reynoso and Bucher 1989). The significance of such declarations is that they permit and justify the "control" of the species even when it may face elimination within the country (e.g., blue-fronted amazon parrots). For these and other reasons, Reynoso and Bucher (1989) recommended that the pest status of all species currently listed as pests needs to be re-evaluated nationally and provincially, and that new criteria need to be agreed upon for future designation of animals as pests. If not, some currently declared species, such as parrots, may face elimination (Bucher 1992*b*). Likewise, as agriculture frontiers—a notable example being rice farms—expand, protected, valued

species such as capybara (*Hydrochaeris hydrochaeris*) that once lived in isolated, non-confrontational habitats may also face population reductions as they obtain pest status.

Renewable resources.- Managing animals, plants, or entire ecosystems as renewable or sustainable resources is a concept currently receiving considerable attention (see Robinson and Redford 1991) and would seem to rightly merit consideration for some species considered agricultural pests in Argentina—eared doves, waterfowl, and parrots. However, as noted by Beissinger and Bucher (1992), such an approach requires, among other things, important policy decisions and considerable baseline biological data on which to make management decisions, data which are not available for most species (Freese and Saavedra 1991). Simply establishing ecologically-based recommendations for hunting limits to replace the arbitrary ones currently in existence for waterfowl populations in Argentina would require an enormous, multi-country, long-term research effort (Zaccagnini and Venturino 1992). Nonetheless, a management strategy whereby different individuals and organizations recognize the value of a particular specie's resource and establish cooperative efforts to assure its sustainability would seem to be a very valuable approach to VPM for certain species. Mechanisms may need to be found to avoid or compensate the economic losses some sectors may encounter in the implementation of such approaches.

Technology development.- Tools and techniques obviously are needed to implement VPM (Reidinger 1990). Those developed in the past and still in use need to be examined for their applicability in current agricultural, economic, and environmental settings. Current tools should be improved, and new tools developed to meet the expected needs of the future. However, "off the shelf" technology needs to be incorporated into management strategies—not used to replace the strategy itself whenever and wherever an animal is in conflict with man's interest. Sophisticated and expensive control may be unwarranted in most situations (Feare 1991), undesirable for birds such as parrots, whose populations can be greatly jeopardized by exploitation (Bucher 1992*b*), and incompatible with the concept of sustainability for species such as waterfowl and doves (Zaccagnini and Venturino 1993).

The lessons learned from decades of red-billed quelea (*Quelea quelea*) research in Africa (Bruggers and Elliott 1989, Jaeger 1992, Ward 1973, 1979) and coyote (Fall 1990) and urban rodent (Davis 1972) research in the United States should be considered. In these cases, after years of attempts to control these species by population reduction, they still exist in numbers at least as great as when population reduction was initiated. It has eventually been recognized that appropriate tools were more effective as part of management strategies to reduce specific, local losses—not simply to eliminate animal populations. Similar examples of using appropriate tools and techniques in a management strategy based on a thorough knowledge of the pest species include management of rodent damage to rice in the Philippines (Fall 1982, 1990), rodent damage to coconut in the Philippines (Fiedler *et al.* 1982), vampire bat predation to livestock in Latin America (Mitchell 1986), and rodent damage to crops in Bangladesh (Sultana and Jaeger 1992). In all of these situations, a critical link was farmer involvement.

In Argentina, tools are already available for controlling monk parakeets, and it is likely that through adaptive research some of those techniques used to manage blackbird depredations in North America would be effective on eared doves. The challenge is to determine when and under what circumstances these techniques are useful and appropriate, to evaluate their use in these situations, and then to make changes as needed.

Deciding on and testing management strategies for these species and collecting data on which to base strategies for other species such as parrots, blackbirds, and waterfowl will be a lengthy, costly, and difficult process. When the status of VPM in Argentina is again reviewed, we hope that many more wildlife biologists will be in important research or decision-making positions, that management strategies will be in place for some species, and that the data collection process will be well underway for others. Resolution of economic and environmental damage by wildlife will become more complex as concerns with related environmental and biodiversity issues increase. Ultimately some species and even some threshold level of losses may have to be increasingly tolerated as part of livestock and/or agricultural production.

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