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**ABSTRACT.** The purpose of this study was to estimate the size and trend of feral pig population within Bahía Samborombón Conservation Area, Buenos Aires Province, Argentina, prior to the elaboration of management strategies. Aerial counts were used to assess abundance of feral pigs \textit{Sus scrofa} along a 45-month period. Mean number of observed individuals was 99.9 ± SE 19.5 per aerial count, Range: 48-526. Population and density estimations were 2612 ± SE 442 individuals and 1.65 ± SE 0.3 ind/km\textsuperscript{2}, with a maximum of 7726 ± SE 235.1 individuals and 5.04 ind/km\textsuperscript{2}, density (September 1997) and minimum of 514 ± SE 383.4 individuals and 0.33 ind/km\textsuperscript{2}, density (June 1995). Feral pig population of Bahía Samborombón increased significantly during the 45-month period from 1995 to 1998 (Pearson correlation coefficient: \( r = 0.81, P < 0.05 \)).

**RESUMEN:** Estimación poblacional del chancho cimarrón \textit{Sus scrofa} en el Área de Conservación Bahía Samborombón, Provincia de Buenos Aires, Argentina. El objetivo de este trabajo fue estimar el tamaño poblacional del chancho cimarrón y su evolución en el Área de Conservación Bahía Samborombón, Provincia de Buenos Aires, Argentina, como paso previo a la elaboración de una estrategia de manejo de esta especie. Se utilizaron conteos aéreos para estimar la abundancia de chanchos cimarrones en un período de 45 meses. El número promedio de individuos observados fue de 99.9 ± EE 19.5, Rango: 48-526. La media de las estimaciones poblacionales y de densidad fue de 2612 ± EE 442 individuos y 1.65 ± EE 0.3 ind/km\textsuperscript{2}, con un máximo de 7726 ± EE 235.1 individuos y una densidad de 5.04 ind/km\textsuperscript{2} (septiembre de 1997) y un mínimo de 514 individuos y una densidad de 0.33 ind/km\textsuperscript{2} (junio de 1995). La población del chancho cimarrón del área de Conservación Bahía Samborombón se ha incrementado significativamente en el período de 45 meses que se extendió entre 1995 y 1998 (Coeficiente de correlación de Pearson: \( r = 0.81, P < 0.05 \)).

**Keywords:** \textit{Sus scrofa}, aerial counts, introduced species, conservation, Bahía Samborombón, Argentina

**Palabras clave:** \textit{Sus scrofa}, conteos aéreos, especie introducida, conservación, Bahía Samborombón, Argentina
INTRODUCTION

Since the early stages of expansion and dispersion of the Europeans, the pig (*Sus scrofa*), in both its domestic variety and derived feral form, has become established in every continent except Antarctica, in addition to a large number of oceanic islands (Oliver and Brisbin, 1993). The majority of the naturalized populations are regional variants or derivatives of the Eurasian wild pig. The success of this species is related to its wide tolerance to different climatic conditions ranging from sub-Antarctic to tropical environments, its omnivorous diet, and the highest reproductive rate known among ungulates (Read and Harvey, 1989; Oliver and Brisbin, 1993).

*Sus scrofa* has been reported having a detrimental impact in livestock, agricultural activities, and the environment in several places where naturalised populations occur (Bratton, 1975; Pavlov and Hone, 1982; Singer et al., 1984; Choquenot et al., 1996).

In Argentina, some of the *Sus scrofa* wild populations are descendants of the several breeds of the domestic pig released since the Spanish colonisation (Crosby, 1986). In addition, pure Eurasian wild boars were deliberately introduced around 1906 for sport hunting purposes (Daciuk, 1978; Navas, 1987). Hybridisation between wild populations and free ranging domesticates is also common all along its range, resulting in a very confusing pattern of distribution and interrelationship of naturalised, domestic and hybrid forms. Currently, the species is widely distributed inhabiting regions where the available habitats are less affected by anthropogenic activities.

At Buenos Aires province, wild pigs (feral pigs and wild boar forms) are found within 12 main districts, out of 122 districts in the province (Galliari et al., 1991). In Bahía Samborombón Conservation Area, wild pigs may prey upon pampa’s deer *Ozotoceros bezoarticus* fawns, the most endangered ungulate of the pampean region (Wemmer, 1998), and may even compete for space or displace the pampa’s deer (Carpinetti, 1998).

At present, there is few published information about distribution and abundance of feral pig or wild boar populations in Argentina (Daciuk, 1978; Navas, 1987; Bonino, 1995). This information is fundamental for planning and implementing of appropriated management strategies especially in conservation areas where the species may have a detrimental impact on local biota as the cases of some National Parks as El Palmar, Lihuel-Calel and Lanin or other protected areas as the Nacuñan Natural Reserve (Ojeda et al., 1998; Govetto, 1999; Sanguinetti et al., 2001).

The purpose of this study was to estimate the feral pig population size and trend within Bahía Samborombón Conservation Area, Buenos Aires Province, Argentina, as a previous step to elaborate strategies for its management.

MATERIALS AND METHODS

Study site

Bahía Samborombón is located in the western coast of the Río de la Plata estuary, extending along the coast from Punta Piedras in the North to Punta Rasa in the South, delimited by the Provincial Road Nº11 to the West. Two main rivers (Salado and Samborombón) and numerous smaller artificial waterways and streams flow into the bay (Fig. 1).

The area contains a variety of habitats ranging from intertidal mudflats and creeks, tidal salt marshes, permanent as well as seasonally flooded freshwater lagoons and marshes, slow-flowing streams, and grasslands to islands of higher ground with trees (mostly *Celtis tala*) and shrubs. The “cangrejales”, with very high densities of river crabs (*Chasmagnathus granulatus*) are an example of the extremely rich productivity of this area.

The climate in the region is temperate with hot summers (December-March) and cold wet winters (June-August). The mean annual temperature is 15°C, with summer and winter means of 21°C and 9°C respectively. Annual rainfall, around 1000 mm, presents four maximum peaks (September, December, March and May/June) and two minimum (August and January).

Bahía Samborombón Conservation Area is situated within the Pampenan grassland phytogeographic province (Cabrera, 1971). The vegetation of the area is a mosaic dominated primarily by edaphic factors. The main determining factors are: a) extent and duration of flooding, be it estuarine or fresh water, and b) the concentration of ions in the soil. Except for the small “tala” (*Celtis tala*) forest patches, which grow on the higher ground (bank of
calcareous soil), all other vegetation is mainly herbaceous (e.g. *Spartina alterniflora, Salicornia ambiguа, Distichlis spicata, Cortaderia selloana* and *Zizanopsis bonariensis*).

Bahía Samborombón Conservation Area has a special significance as a refuge for other wildlife species that have disappeared in other parts of the Pampas region. Even when access and activities in the area are controlled, poaching still occur, especially on Pampas deer and feral pigs.

**Methodology**

Twenty aerial counts were undertaken over a 45-month period, between March 1995 and November 1998, using a high-wing single engine plane, Cessna 172. The flight path was a belt of transects stretching from the mouth of the Río Salado (35° 19' S, 56° 47' W) to the Ría de Ajó (36° 20' S, 62° 20' W) (**Fig. 1**). We flew 10 transects per count, 300 m wide on each side of the aircraft (Bothma et al., 1990) of variable length (7-20 km), totaling 173.8
km. Transects 1 to 5 were NW-SE direction whereas transects 6 to 10 were in the opposite direction. All flight paths were fixed and transects were surveyed without replacement at a speed of 120 km/hr at an altitude of 80 m. The area between coastline and Provincial Road Nº11 (1531.34 km²) was employed to estimate the total feral pig population.

Observers in the rear right and left positions of the plane counted all individuals within the transect (marked by the struts of the aircraft). A third member of the team, at the front right of the plane, was responsible for navigation with the use of a GPS. There were no changes in the composition of observers during the study. Counts were made during the first three hours of daylight under conditions of little or no clouds or wind. The number of possible aerial counts depended on availability of planes and on budget limitations. A total of 62 hours were flown.

The pig population density was estimated for each count, using an unequal-size units ratio method (Krebs, 1989: 108). In a survey with aerial transects of differing lengths, the approach is to calculate density for each transect and extrapolate this to the total census zone (Jolly, 1969; Krebs, 1989). The first step is to calculate average density for the whole area from the equation

$$R = \frac{\sum y_i}{\sum z_i}$$

where $y_i$ is total animals counted in transect $i$, $z_i$ area of transect $i$, $i$ sample number (1, 2, 3, …, $n$) and $n$ total number of transect counted. The total population is therefore

$$U = RZ$$

where $Z$ is area total census zone and $R$ average density per unit area. Results are given as the estimated population size, density (ind/km²) ± their standard error (SE) and mean group size ± SE.

**RESULTS**

A total of 3,427 pigs were counted in 789 groups. The mean number of individuals observed per aerial counts was 99.9 ± SE 19.5 (range: 48-526). Population and density estimations were 2612 ± SE 442 individuals and 1.65 ± SE 0.3 ind/km² (Table 1). We also observed a population increase between 1995 and 1998 (Pearson correlation coefficient: $r = 0.81$, $P<0.05$) (Fig. 2). Mean group size was 4.3 ± 0.12 individuals, which increased slightly relative to the increase in overall population size (Pearson correlation coefficient: $r = 0.54$, $P<0.05$). The maximum mean group size was 5.86 ± 1.09, in September 1996, and the minimum mean was 2.7 ± 0.49, in May 1995 (Table 1).

**DISCUSSION**

Aerial counting is one of the fastest and cheapest methods to estimate populations of large mammals, as used for feral pig counts in Australia (Hone, 1983; Wilson et al., 1987). One of its greatest disadvantages is that it underestimates the size of populations, due to different factors, among which the visibility of the animals from the air is an important one (Caughley, 1974).

Our results suggest an accelerated increase of the population in a very short time. The pig population estimates varied between month; lowest estimates were for the late summer months. This could be due to the high temperatures, which may have forced the animals to be more crepuscular or nocturnal (Baber and Coblentz, 1986). Additionally, during these months, the *Zizanopsis bonariensis* grasslands, which occupy around 35% of the area are dark brown (Vervoorst, 1967) and therefore may affect visibility.

The biology and ecology of feral pigs in Bahía Samborombón Conservation Area are poorly understood. However, there is information from experiences in other regions, such as Australia (Choquenot et al., 1996) that can be used for management planning purposes.

Feral pigs are habitat generalists and have colonized a wide range of habitats all over the world. Their opportunistic feeding habits and omnivorous diet allow them to exploit various temporarily abundant food sources (Baber and Coblentz, 1986; Klaa, 1991). The species have a high reproductive capability and breed at any time of year, but environmental factors tend to impose some seasonality (Choquenot et al., 1996). Feral pigs are sensitive to high temperatures. In environments with mean temperatures above 30°C, pigs need daily access to water (Choquenot et al., 1996). Additionally, pigs are particularly sensitive to variations in food availability, which directly affects their reproductive rate (Baber and Coblentz, 1986).

Bahía Samborombón Conservation Area offers to the feral pigs an environment without these limitations, as the mean temperature in the hottest months does not surpass 21°C (De Fina, 1978), and has plenty of watercourses.
Table 1
Total numbers of feral pigs recorded, density, population and group size estimated for each aerial count

<table>
<thead>
<tr>
<th>Date</th>
<th>Accumulated time (months)</th>
<th>Nº of individuals observed</th>
<th>Density (R) Ind/km²</th>
<th>Population (Y) +/- SE</th>
<th>Nº of Groups X +/- SE</th>
<th>Group size observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 95</td>
<td>1</td>
<td>48</td>
<td>0.4603</td>
<td>705.0 +/- 42.48</td>
<td>3.125 +/- 0.65</td>
<td>16</td>
</tr>
<tr>
<td>April 95</td>
<td>2</td>
<td>52</td>
<td>0.4987</td>
<td>765.4 +/- 43.50</td>
<td>2.7 +/- 0.49</td>
<td>31</td>
</tr>
<tr>
<td>May 95</td>
<td>3</td>
<td>50</td>
<td>0.4823</td>
<td>738.6 +/- 381</td>
<td>4.04 +/- 0.56</td>
<td>23</td>
</tr>
<tr>
<td>June 95</td>
<td>4</td>
<td>35</td>
<td>0.333</td>
<td>514.04 +/- 383.47</td>
<td>3.43 +/- 0.67</td>
<td>16</td>
</tr>
<tr>
<td>July 95</td>
<td>5</td>
<td>53</td>
<td>0.4699</td>
<td>719.72 +/- 312.45</td>
<td>3.6 +/- 0.57</td>
<td>20</td>
</tr>
<tr>
<td>August 95</td>
<td>6</td>
<td>63</td>
<td>0.6041</td>
<td>925.36 +/- 513.96</td>
<td>5.15 +/- 0.89</td>
<td>19</td>
</tr>
<tr>
<td>September 95</td>
<td>7</td>
<td>106</td>
<td>1.0549</td>
<td>1615.71 +/- 706.2</td>
<td>4.55 +/- 0.69</td>
<td>36</td>
</tr>
<tr>
<td>September 96</td>
<td>19</td>
<td>202</td>
<td>1.9467</td>
<td>2981.71 +/- 135.2</td>
<td>5.86 +/- 1.09</td>
<td>37</td>
</tr>
<tr>
<td>October 96</td>
<td>20</td>
<td>184</td>
<td>1.7645</td>
<td>2702.64 +/- 806.1</td>
<td>4.14 +/- 0.43</td>
<td>48</td>
</tr>
<tr>
<td>March 97</td>
<td>25</td>
<td>119</td>
<td>1.1412</td>
<td>1747.9 +/- 444.08</td>
<td>2.91 +/- 0.7</td>
<td>17</td>
</tr>
<tr>
<td>April 97</td>
<td>26</td>
<td>80</td>
<td>0.7640</td>
<td>1175.06 +/- 639.85</td>
<td>2.92 +/- 0.33</td>
<td>40</td>
</tr>
<tr>
<td>June 97</td>
<td>28</td>
<td>274</td>
<td>2.627</td>
<td>4024.58 +/- 1906</td>
<td>4.81 +/- 0.57</td>
<td>65</td>
</tr>
<tr>
<td>July 97</td>
<td>29</td>
<td>269</td>
<td>2.57</td>
<td>3951.14 +/- 1570</td>
<td>5.26 +/- 0.74</td>
<td>42</td>
</tr>
<tr>
<td>August 97</td>
<td>30</td>
<td>349</td>
<td>3.3468</td>
<td>5126.2 +/- 235.12</td>
<td>3.66 +/- 0.41</td>
<td>24</td>
</tr>
<tr>
<td>September 97</td>
<td>31</td>
<td>526</td>
<td>5.0441</td>
<td>7726.02 +/- 235.44</td>
<td>5.36 +/- 0.64</td>
<td>84</td>
</tr>
<tr>
<td>October 97</td>
<td>32</td>
<td>152</td>
<td>1.4576</td>
<td>2233.61 +/- 694.46</td>
<td>3.2 +/- 0.38</td>
<td>40</td>
</tr>
<tr>
<td>November 97</td>
<td>33</td>
<td>318</td>
<td>3.0591</td>
<td>4685.55 +/- 122.46</td>
<td>4.66 +/- 0.56</td>
<td>60</td>
</tr>
<tr>
<td>August 98</td>
<td>42</td>
<td>234</td>
<td>2.244</td>
<td>3437.05 +/- 106.1</td>
<td>3.71 +/- 0.34</td>
<td>71</td>
</tr>
<tr>
<td>October 98</td>
<td>44</td>
<td>322</td>
<td>3.090</td>
<td>4734.15 +/- 167.11</td>
<td>4.8 +/- 0.59</td>
<td>67</td>
</tr>
<tr>
<td>November 98</td>
<td>45</td>
<td>166</td>
<td>1.5919</td>
<td>2438.22 +/- 103.6</td>
<td>4.87 +/- 0.75</td>
<td>32</td>
</tr>
</tbody>
</table>
At the current population level, food supply seems not to be limiting due to their omnivorous diet and the high productivity of the wetlands (Canevari et al., 1998).

The authors’ preliminary observations have shown a potential dispersal from Bahía Samborombón Conservation Area to the agricultural land surrounding it. To manage the rapid increase of its population and to avoid further environmental damage, we suggest that a control program for pigs must be implemented urgently. However, decisions about pest control require a co-operative multidisciplinary approach (Braysher, 1993; Bruggers and Zaccagnini, 1994; Choquenot et al., 1996). Economics can help in deciding whether it is worthwhile trying to eradicate feral pigs, exclude them from some areas or reduce their population and to what extent; but previous any economic analysis basic biological and technical information must be available (Bomford and O’Brien, 1995).

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LITERATURE CITED


