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An Overview on Feral Hog Management in Brazil after Three Years of Control Regulation

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ABSTRACT: Feral hogs are known to be expanding their range in Brazil since late 1980s and reports of damage to crops and livestock predation have become more frequent lately. Just recently, the use of lethal methods for feral hog control was legalized in Brazil, and there are still several restrictions, particularly towards the purchase and transportation of guns and ammunition. Results of questionnaires from feral hog hunters showed that around half of them still act illegally, and hunting with dogs was the main technique used for controlling feral hogs. We believe that to enhance feral hog control in Brazil, legislation needs to be reviewed, and a national control program needs to be created involving researchers, government agencies, and hunters, working together on development and implementation of more efficient techniques for feral hog population control.

KEY WORDS: Brazil, control methods, economics, feral hogs, hunting, legislation, *Sus scrofa*, swine, wild pig

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INTRODUCTION

Wild boars (*Sus scrofa*), originally from Eurasia and Southeastern Africa, were commonly introduced into Spanish and Portuguese colonies as source of protein, and they established feral populations that became invasive worldwide (Long 2003). In South America, hogs were introduced in the 16th century by the colonizers. In the early 1900s, wild boars were brought to Argentina, Chile, and Uruguay, eventually escaping from hunting ranches and spreading over the continent (Jaksic et al. 2002, Lombardi et al. 2015). By the 1990s, approximately 10% of South America had established feral hog populations, and these were expanding at rates much greater than what would be normally expected (Salvador 2012).

In Brazil, feral hogs were first recorded in 1989 near the border with Uruguay, and damage on corn crops was reported by farmers just three years later (Deberdt and Scherer 2007). The popularity of feral hogs as game animals and for exotic meat grew in the 1990s, and several breeding and rearing operations, both legal and illegal, were established; some even imported new genetic (pure) lines from Europe. Subsequently, Brazil's government prohibited new wild hog farms (Salvador 2012), after which a generalized release of animals into the wild occurred around 2000 to 2005 for economic reasons.

Currently, the main source for feral hog expansion, besides natural dispersion from established populations (i.e., South Brazil) is translocation for establishing new populations for hunting or meat production (Deberdt and Scherer, 2007; Salvador 2012). In some regions (e.g., South and Pantanal) domestic pigs are traditionally raised free-ranging, resulting in increased opportunity for crossbreeding with the feral swine. This has resulted in a very fast spread of the species over several parts of the country in the past few decades (Deberdt and Scherer 2007, Pedrosa et al. 2015). Feral hogs are present in all five Brazilian political regions, with major concentrations in the South and Southeast (Pedrosa et al. 2015), where estimations of feral hog population density range from 0.22 to 22.3 per square-km (Salvador 2012, Puertas 2015). Since the late 20th century, conflicts between feral hogs and humans have been increasing in Brazil, resulting in economic losses (Salvador 2012, Pedrosa et al. 2015), decline of water resources quality (Rosa 2015), and threats to commercial pig operations. Feral hogs are known to host numerous parasites and zoonoses, including internationally controlled diseases that can put commercial farms and native biodiversity at high risk (Nöckler et al. 2006, Jarvis et al. 2007, Herrera et al. 2008, Naranjo et al. 2008, Ruiz-Fons et al. 2008).

Table 1. Summary of the Brazilian laws regarding feral hog control at state (Rio Grande do Sul, RS; Santa Catarina, SC; Paraná, PR; Mato Grosso do Sul, MS) and national level.

Year	Law or Ordinance	Level	Character
1995	IBAMA Ordinance 7/95	RS	Authorized feral hog control in 11 counties, for 3.5 months.
2002	IBAMA Ordinance 138/02	RS	Authorized feral hog control in 11 counties, for one year.
2004	IBAMA NI 25/04	RS	Authorized feral hog capture and harvest, for one year.
2005	IBAMA NI 71/05	RS	Authorized feral hog control, for undetermined period of time
2007	SAR Ordinance 010/07	SC	Authorized temporarily feral hog hunting with stands and feeders, forbidding traps and dogs.
2009	IAP Ordinance 98/09	PR	Regulates feral hog control within the Vila Velha State Park.
2010	SAR Ordinance 1/10	SC	Extends feral hog control authorization, maintaining restrictions towards traps and dogs.
2010	SMAC Ordinance 001/10	MS	Establishes emergencies feral hog control actions, through an intervention group.
2010	SAR Ordinance 20/10	SC	Declares feral hogs as novice animals, and regulates control without restrictions.
2010	SEAPPA Ordinance 183/10	RS	Allows feral hog control, not setting timeframe.
2013	IBAMA NI 3/13	National	Regulates feral hog control nationwide.

In 2013, 24 years after the first feral hogs in Brazil, lethal methods for population control were authorized by Brazilian Institute for Environment and Renewable Natural Resources (IBAMA), through the Normative Instruction 03/2013 (NI 03/2013). This is the country's first population control regulation for invasive vertebrates nationwide. We present a summary of feral hog control three years after this legalization. Our work is divided in four sections: 1) a summary and critique of laws; 2) results from questionnaires applied to farmers and hunters on control techniques; 3) a summary and evaluation from a political perspective; and 4) discussion of our perception of the whole situation, and the main implications of our findings for enhancing feral hog control in the Brazilian territory.

BRAZILIAN ENVIRONMENTAL LAWS AND THE FERAL HOG CONTROL

Historic of Brazilian Environmental Laws

Brazil is known for some of the strictest environmental laws worldwide, especially regarding the use of wildlife as resource (but see Nascimento et al. 2015 for fishery resources) and lethal methods for invasive alien vertebrate species control. The first Brazilian environmental law regulating hunting and fishing appears in 1934 (Decree 23,672/34). Thirty years later, the Federal Government approved the wildlife protection Law 5,197/67 (also known as the "hunting code"), restricting commercial hunting and the introduction of alien species. In 1988, the Brazilian Federal Constitution (Article 225, § 1º, I, VII) establish the responsibility of the government and the public for the protection of native fauna and flora, and for the management of Brazilian species toward healthy ecosystems. In 1994, the Brazilian government ratified their signature of the Convention on Biological Diversity by the Legislative Decree 2/94. It emphasized the risk of biological invasions, the need for precautionary measures, and implementation of eradication or control measures for alien invasive species.

Six years after the first record of feral hogs in Brazil, control measures were authorized experimentally in 1995,

2002, and 2004 in Rio Grande do Sul (RS). Because regulations required that hunters be accompanied by federal agents, and had limited expertise, little success was achieved. In 2005, another federal Normative Instruction permitted control in RS and in 2007 in Santa Catarina (SC); however, restrictions on trapping and dog hunting limited the effectiveness of these measures and the recruitment of hunters. National control measures were revoked in 2010 because of pressure from animal rights groups (Table 1). At that time, the federal government passed to the states the responsibility for regulating feral hog control. Only RS and SC soon approved new, but still very restrictive, legislation. Two other pilot projects were planned in the states of Paraná and Mato Grosso do Sul, but little or no action was taken (Table 1). Bureaucracy and lack of information held back the evolution of discussions. Meanwhile, feral hog problems kept growing as the populations increased and spread. Only in 2013, due to much pressure from farming federations and associations, IBAMA finally authorized lethal feral hog control nationwide, especially for achieving from OIE-FAO the status of "free from classic swine fever."

Nationwide Feral Hog Control: A Critical View

The Normative Instruction 03/2013 allowed feral hog population control by lethal methods in all Brazilian territory and by any citizen, with no seasons or bag limit. For such, hunters need to register in IBAMA and obtain a license at the office, in person (or in some places by mail). The license needs to be updated and renewed every three months, informing the agency the number of animals killed, category (sex and size), method, and location. This process of reporting the animals harvested and obtaining a new authorization can take up to one month and is not easily accessible for everybody, especially those in more rural areas. To using firearms, hunters need to be associated with a hunting or shooting club, and must go through a very expensive and exhaustive process within the Brazilian Army, which can easily take over one year and cost more than \$1,000 for paperwork, tests, examinations, and memberships (based on the February 2016 exchange rate

of approximately 4 Real = US\$1). The price of the equipment and ammunition is also cost-prohibitive, being around three times the cost of similar items in U.S.

For evaluating the applicability of NI 03/2013, we created a semi-structured online questionnaire, presented between June and August 2015 to feral hog hunters all over the country through hunting clubs, blogs, and social networks (i.e., Facebook). The questionnaire was applied using Google Forms[®], with no obligation of providing individual identification or of answering all the questions. Hunters were asked about the legal procedures required for feral hog control, and they were able to choose more than one answer for multiple-choice questions. Because of the methodology used, our sampling was directed to recreational and commercial hunters with high education levels (61% with college degrees, 38% with high school diplomas) and relatively high income (21% with monthly wages >\$2,350, with only 3% earning minimum wage of around \$220/month). Thus we expected to have excluded most of the rural population that have limited access to internet, including farmers who control feral hogs in their own properties.

Our results show that most of the interviewed were permitted by both IBAMA (60%; $N_{\text{total}} = 126$) and by the Brazilian Army (66%; $N_{\text{total}} = 103$). However, around half of those (48%; $N_{\text{total}} = 81$) were not up to date with their reports to IBAMA, mainly because of lack of economic resources (55%; $N_{\text{total}} = 38$) and logistical challenges to deliver them to the agency's office (average 268 km; $N = 52$). Struggles in writing the reports or unfamiliarity with the format of the required report was noted 34% of the answers, owing to a lack of communication. Those hunters without IBAMA authorization (46%; $N_{\text{Total}} = 45$) reported bureaucracy as the main reason for failure to obtain authorization. Lack of information about the authorization was noted by 33% of illegal hunters. Many stressed the need for an electronic system, where the information could be exchanged via internet, especially for report submission. The need for extending the license expiration date to one year (instead of 3 months) was one of the main requests. Because the Army authorization for gun transportation is linked to this document, it also must be renewed every three months. Many illegal hunters showed interest in applying for authorization in order to avoid prosecution.

Regarding the process for gun registration and transportation in the Army, the most common complains are about the delays on getting the authorizations (sometimes over one year), and subjectivity of the Army personnel in issuing the permits. Further, the caliber of firearms for hunting is restricted based on the energy at the muzzle; firearms and ammunition suited for shooting feral hogs are available only those who are engaged in hunting or shooting clubs, limiting access to and virtually excluding all farmers from having such tools.

CONTROL METHODS

Two procedures were used for evaluating control methods in use: the online questionnaire (as explained in the previous section), and an in-person survey with farmers and controllers, in two different counties and political regions: itamonte, mg (22°21 s; 44°47 w); and santana do

livramento, rs (30°53 s; 55°31 w). In both cases, respondents were asked about the number of feral hogs killed in one year, methods used, type of property where the control was done, and motivation (online only). These counties were chosen because of our connections within the community, which allowed for more reliable answers, especially among those who are not up-to-date with all documentation required.

Itamonte has large areas of territory (80%) preserved by different Protected areas of Brazilian Atlantic Forest. Terrain characteristics (altitude from 900 to 2,791 m) hinder the mechanization of agriculture, resulting in properties with polycultures (e.g., corn, sugarcane, cassava, beans, soybeans, and sunflower) and high levels of forests fragments. Santana do Livramento is covered mostly by grasslands ecosystems. In general, native forests are restricted to riparian areas, with small to mid-sized trees and bushes. The region still has a large area of remnant native grasslands and forest, mainly because of the shallow soils that limit agriculture. The landscape is characterized mainly by livestock production (beef cattle and sheep), rice and soybeans fields, dairy farms (with sorghum crops), and eucalyptus.

Data were collected from January to March 2014 in Itamonte, and throughout 2015 in Santana do Livramento. We conducted interviews with local community using snowball sampling technique (Browne 2005, Sheu et al. 2009). Because feral hog control is often performed illegally in rural communities, the questionnaire applied collected no personal information. For assessing hunting selectivity towards a specific category of the feral hog population, we calculated the number of females and males harvested and conducted analysis using the Kruskal-Wallis test for non-normal data at the 0.05 significance level, using BioEstat 5.0 (Ayres et al. 2007).

From the 126 hunters interviewed online, most (83%) were from South and Southeastern Brazil. They reported 2,112 feral hogs killed in the period of one year (931 females; 1,036 males). Each hunter killed a mean of 16.8 ± 25.36 feral hogs, without differentiation between females and males (7.4 ± 11.97 and 8.2 ± 12.9 feral hog/hunter, respectively; $H = 0.488$; $p = 0.4848$). Also 14% ($N = 294$) of animals killed were piglets, and of the females killed, 28% ($N = 257$) were pregnant. The main techniques used for controlling feral hogs were hunting (94%), stands (46%), and trapping (16%) (Figure 1); 46% of the hunters used more than one technique (because multiple techniques could be reported, some results total >100%). "Hunting" refers to all types of hunting involving persecution and catch of the prey done on foot, horseback, or vehicle, with or without use of dogs. Hunting with dogs was shown to be the preference of most hunters (82%; $N_{\text{Total}} = 119$). Stands consists of choosing a place naturally used by feral hogs (recognized previously by searching for hog sign, or near feeding or bath places) or by setting artificial places or bait to attract the animals. Temporary structures or fixed platforms high off the ground were normally used for concealment. The traps could be corral, for catching larger groups, or small cage traps. For disposing the feral hogs captured, hunters use both guns (70%; $N_{\text{Total}} = 124$) and "white weapons" (cutting weapons such as knives) (74%; $N_{\text{Total}} = 125$). Most of those use knives

(87%) and some also archery (39%). Archery has been an increasing choice because of difficulty on getting the required documentation for gun permits. Snares, although prohibited by NI 03/2013, were noted in 5.5% of the reports.

The motivation for hunting ($N = 118$) was mainly for population control (78%), or trophy/sport hunting and for food (40% each). Only 6% of hunters were motivated exclusively for meat consumption. Most hunters used third-party propriety for hunting (86%; $N_{Total} = 105$), while only 22% hunt in their own land, and 8% hunt in preservation areas in partnership with managers. Meat consumption was reported by all hunters; the NI 03/2013 strictly prohibits the transportation of live feral hogs, but the destination of carcasses is a large omission in the legislation.

We interviewed 38 farmers from Itamonte and from Santana do Livramento who performed feral hog control. A total of 224 feral hogs were killed in one year, 98 in Itamonte (12.2 ± 4.3 feral hog/hunter) and 126 in Santana do Livramento (21 ± 15.8 feral hog/hunter). There was no difference between males and females killed (9.2 ± 8.3 and 8.3 ± 5.5 feral hog/hunter, respectively; $F = 0.0043$; $p = 0.9475$). We identified four control methods: corral trap and cages with bait; trench with bait; hunting; and stands. The trench was used only by Itamonte community and consists in a ditch commonly used for silage storage that was adapted to work as a corral trap. Hunting was the most used technique (59%) (Figure 1), and dogs were used 84% of the time. Despite the higher efficiency and practicability of traps, most farmers are unfamiliar with the technique, and some lack experience in the setting-up process, causing them to fail and to be regarded as inefficient. Our perception is that most of the traps used are small cages, allowing one or few animals in, which could be affecting the efficiency and therefore preference for the technique.

Local residents of both counties report feral hog economic impacts, but exact amount of losses was hard to obtain. In Itamonte, farmers reported losses of agricultural production, particularly sugarcane, corn, and cassava. They also reported feral hogs approaching houses, attacking gardens, destroying springs, feeding on livestock carcasses, and crossbreeding with domestic pigs. In Santana do Livramento, farmers reported losses of 10-50% of lamb production, and in one case it was reported 250 lambs were predated, estimated in value at \$7,600. In 2013, a survey by the Ranchers Association in the county reported 20,000 lambs lost, representing around \$600,000 in direct losses (ARCO 2013).

POLITICAL LEVEL

Foreseeing the lack of action from the government, many citizens begin discussion of the invasion, and groups of volunteers arise. Some of those are the “Aqui Tem Javali” Network (www.aquitemjavali.com.br) that is collecting information on presence of feral hogs since 2008 (Pedrosa et al. 2015), and The Pampa Javali Team in Santana do Livramento, which since 2014 has cooperated on collecting samples for research and publication of extension materials (Mendina Filho et al. 2015). There are also a very large number of organized hunting groups that volunteer to control feral hogs on public and private land.

No control is being directly done by any government agency; however, some agencies (e.g., ICMBIO, Institute Chico Mendes for Conservation of Biodiversity; and IEF-MG, State Institute of Forest from Minas Gerais) support volunteer groups. There is a lack of official technical reports regarding feral hog control in Brazil. To our knowledge, control activities in protected areas [e.g., State Park of Pau Furado-MG, National Forest of Capão Bonito-SP, and Ibirapuitã Environmental Protection Area (RS)] are been done through individual initiatives of the managers with local hunters, without any financial support.

The ICMBio has been engaged with local communities and authorities for discussing effective feral hog control strategies at the Ibirapuitã Environmental Protection Area and in Itatiaia National Park. In 2011, agents from the Ibirapuitã Environmental Protection Area coordinated the first meetings to discuss the local feral hog situation in more depth, and since mid-2015 meetings have been held at the State Legislative Assembly (RS). Those meetings include representatives of environmental agencies, universities, and farmers, but not much progress has been made

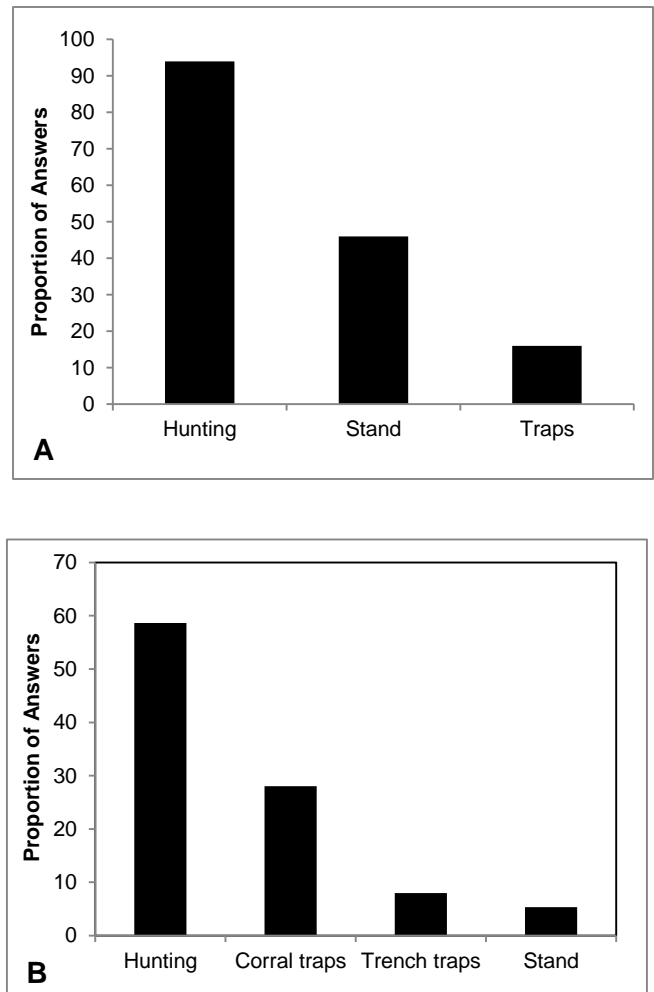


Figure 1. Main techniques used for feral hog control: (A) Online questionnaires; and (B) Farmers of Itamonte and Santana do Livramento Counties.

due lack of knowledge, lots of ideological decisions, and bureaucratic processes. The Itatiaia National Park administration during 2014 and 2015 initiated an experimental feral hog control effort with assistance by non-governmental and research institutions. Around 15 feral hogs were killed by one local hunter using dogs; however, no information on sampling effort or capture success was collected.

Local events in Minas Gerais in 2014 and 2015 (First and Second Workshop for Feral Hog Control in Serra da Mantiqueira, and First Meeting About Feral hog in Minas Gerais) discussed the social, economic, and environmental impacts and control techniques of feral hogs. In all of these events, government agents stressed the need for testing non-lethal methods (e.g., contraceptives, male castration) for controlling feral hogs; however, no financial resources from government agencies were allocated for such efforts. The farmers and hunters also stressed the difficulty of feral hog control due the inertia of government and the cost of control; one hunter reported a cost of around \$150 for each hog killed.

During the second Workshop for Feral Hog Control in Serra da Mantiqueira, we surveyed public opinion using questionnaires applied before and after the event. Agents from 23 governmental and non-governmental institutions, in addition to farmers and hunters, were asked their personal opinions about the relationship between feral hogs and human society, responsibility for control, management, carcass destination, and impressions of the NI 03/2013. Our results pointed out that most (>85%) of 35 respondents believe feral hogs cause negative social and environmental impacts, and for efficient population control the responsibility must be shared between government and civilian society (80%). People believe that the aim of the management must be focused on control of populations (54%) instead the eradication, and on using traps and firearms (31% and 25%), which can provide meat for human consumption (51%). For 12 participants who answered the questionnaire before and after the event, 59% switched from an unfavorable to a favorable opinion on legalization of control. We believe that this change in perception was due to the presence of farmers and hunters explaining their problems and experiences regarding feral hog invasion and control.

IMPLICATIONS FOR FERAL HOG CONTROL IN BRAZIL

We identified two profiles of feral hog hunters: the farmer, aiming to protect livestock and crops; and the recreational hunter, who see feral hogs as an opportunity for legal hunting. However, provisions of NI 03/2013 are often inaccessible for farmers, and the official position of government agencies is that recreational hunting needs to be avoided. Brazilian farmers are the most affected and take most (if not all) the financial loss for the feral hog invasion. In addition, most of them have no training, skills, or time to do proper control. Commonly, rural communities hunt feral hogs as an opportunistic activity (Carvalho et al. 2015) and as an alternative source of protein, resulting in a decrease in hunting pressure on native species (Desbiez et al. 2011, Nielsen et al. 2014, Junker et al. 2015). Massei et al. (2015) suggested the inclusion of

community for enhancing feral hog control, through the creation of professional groups and incentives for community service and civic duty carried out by stakeholder groups. This could be a feasible strategy for keeping the feral hog population down, contributing to mitigate the effects of invasive species on local fauna while helping local livelihoods by improving protein sources.

We favor sport hunting of feral hogs in Brazil, given the high cost of eradication programs (King et al. 2009). Recreational hunting has been sufficient in maintaining low feral hog populations in many places, such as in Europe (Nores et al. 2008, Massei et al. 2015) and the United States (Heffelfinger et al. 2013). Establishment of hunting zones and seasons (see Acevedo et al. 2009) can be useful in evaluating different control techniques and monitoring trends in population density. In addition, hunting zones could benefit affected farmers if they were authorized to sell hunting activities on their lands (Tisdell 1982, Zivin et al. 2000).

In Brazil, the use of dogs is traditional for hunting native species (Neto et al. 2012) and initially has been the most viable way to deal with the feral hog problem, because of little required documentation, and availability of trained dogs and expertise. Dogs are very efficient in removing the residual feral hog population after controlling the major part by other methods (e.g., trapping) (Sturner and Barrett 1991, Caley and Ottley 1995), especially for those feral hogs that are bait shy or trap shy. However, if used alone, dogs are not as effective for large-scale reductions in population (Caley and Ottley 1995). Hunting with dogs also has a bias toward taking more males (as trophy animals), which in terms of population control is less effective (Caley and Ottley 1995). However, an important aspect of Brazilian hunters' behavior is that they hunt both males and females in the same proportion, including pregnant females and piglets, enhancing the population control (Bieber and Ruf 2005, Desbiez et al. 2009).

Traps would be expected to be the most popular method applied by rural communities when the motivation for hunting is property defense (Doughty et al. 2014). However, our results show that this is the least-used technique for feral hog control in Brazil, besides being the most effective method to catch feral hogs, especially piglets (Sturner and Barrett 1991, Caley and Ottley 1995). We need more studies to evaluate the efficacy of different control techniques in Brazil, including the effectiveness of multi-approach measures, since feral hogs learn to escape and evade hunters (Thurfjell et al. 2013).

Finally, there is a gap of 24 years between feral hog invasion and control legalization in Brazil, and still many hunters act illegally because of bureaucracy and lack of information. The lack of regulated hunters may be increasing feral hog populations and their conflicts with human activities (Massei et al. 2015). Brazil might be facing a very challenging situation in future years, especially with several aspects of current environmental and gun laws holding us back even more. The delay and complications in the authorization process is the result of distrust of hunters, and it contributes to enhance the invasion process. Therefore, there is a need for adapting the NI 03/2013 toward reducing the bureaucracy that hinders hunters, and toward implementation of an online system. We believe

that official records would be more reliable with the implementation of an online system. Researchers, government agencies, and hunters could work together to evaluate the efficiency of hunting methods and enhance control techniques used.

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