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RH: Clarke and Brook • Attitudes toward Wild Pigs

Attitudes of Rural Canadians toward Invasive Wild Pigs

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ABSTRACT

Invasive wild pigs (*Sus scrofa*) are now the most widely distributed wild large mammal in the world and they cause dramatic impacts on agriculture and the environment. Wild pigs were first introduced to the Canadian prairies in the 1980s and are now present in all Canadian provinces except those in the farthest east in Atlantic Canada (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador). A telephone survey was conducted with 3007 rural Canadians in all ten provinces in order to quantify the level of awareness and concern regarding invasive wild pig impacts in their province. Rural Canadians have overall low awareness of the presence of wild pigs in their region. As expected, awareness of wild pigs was lowest in provinces where they were absent or rare (<10% of respondents aware in British Columbia, Ontario, Quebec, and Atlantic Canada), low in the two provinces where wild pigs are

well established and relatively widespread in rural areas (22% of respondents aware in Alberta and Manitoba), and moderate awareness in the one province with by far the most expansive distribution of wild pigs (42% of respondents aware in Saskatchewan). In Atlantic Canada where there are no known wild pigs, 2% of respondents incorrectly indicated that they were aware of their presence. Concerns regarding impacts were overall moderate to low, with no province having a mean concern level ≥ 7 out of 10) for crop damage, livestock predation and harassment, structural damage, environmental impacts, threats to native wildlife, disease transmission to humans, or disease transmission to wildlife and livestock, and threats to human safety and well-being. Since rural Canadians experience the direct and indirect impacts from invasive wild pigs, our findings will inform management efforts and help to effectively engage rural Canadians in this rapidly emerging crisis. Communication and collaboration efforts through a range of conventional and social media are needed to help inform rural Canadians about the presence of wild pigs and the associated risks and impacts. Our findings help explain the overall very low effort in most of Canada to develop management strategies and implement control efforts.

KEYWORDS: attitudes, Canada, feral swine, invasive species, wild pig, *Sus scrofa*, wild boar

Invasive wild pigs, *Sus scrofa*, also called wild boar, feral pig, or feral swine (Keiter et al. 2016) are one of the most prolific invasive species in the world and they are rapidly becoming the most widely distributed mammal in the world (Lewis et al. 2017, Keiter and Beasley 2017). Wild pigs were originally native to Eurasia and North Africa, and have now spread to every continent except Antarctica (Mayer and Brisbin 2008, Lewis et al. 2017). As an invasive species they pose

a serious threat to native species and ecosystems as well as agricultural production on a global scale (Keiter and Beasley 2017, McClure et al. 2017). Free-ranging wild pigs are not new to the North America (Schlichting et al. 2016). Wild pigs were first introduced to the United States in the 16th century, but have had a more recent introduction into Canada (Brook and Van Beest 2013).

Domestic Eurasian wild boar were brought to Canada in the 1980s and 1990s as part of an extensive livestock diversification program (Brook and Van Beest 2014, Michel et al. 2017). Over the last 35 years, wild pigs have escaped from domestic wild boar meat production and penned shoot farms, or in some cases were purposely released into the wild when farming was unsustainable or to create new hunting opportunities (Aschim and Brook 2019). Free ranging populations continue to expand exponentially, since wild pigs have very few natural predators, and are generalist feeders (Snow et al. 2017). They are highly fecund, having multiple litters per year, averaging six young per litter in western Canada (Koen et al. 2018). Wild pigs are a long-lived species and can reach >12 years (Michel et al. 2017). Where hunting occurs, mean life expectancy is typically lower (Jezierski 1978). Continuing releases and escapes from existing domestic operations also contribute to population expansions (Koen et al. 2018, Aschim and Brook 2019). Current wild pig range within Canada is >750,000 km² and expanding at a rate of 88,000 km² per year (Aschim and Brook 2019).

The potential for economic and environmental impacts from wild pigs in Canada is high (Brook and Van Beest 2013, Michel et al. 2017) and is consistent with risks and impacts documented across their native and introduced ranges (Barrios-Garcia 2012). Wild pigs can cause damage to

ecological communities by altering the biodiversity and community composition of native species, even to the point of local extirpation (Massei 2011, van Beest et al. 2015, McClure et al. 2018). Wild pigs depredate livestock and cause extensive crop damage, exceeding 1.5 billion US dollars/year (McGregor et al. 2015). The main impacts include direct feeding on plants, rooting, and trampling. Wild pigs harass and prey on lambs, goats, beef calves, and exotic game species (Beach 1993). Wild pigs have also been observed to forage with livestock and wildlife at feeding sites, which are potential sites for disease transmission (Beach 1993, Brook 2019). Free ranging wild pigs can potentially carry and spread at least 30 viral, bacterial, and parasitic pathogens that can impact human and livestock health (Meng et al. 2009, Podgorski et al. 2018) and may generate considerable public concern.

Human dimensions research has demonstrated the need for information on the attitudes of stakeholders regarding impacts and risks of invasive species to inform management efforts (Harper et al. 2016). A common failure in invasive species management is the assumption that the most effective methods to gather information on these non-native species are ecological, biological, or laboratory methods (Rollins et al. 2007). Several ecological methods including radio telemetry, camera trapping, or biomarkers have been used in the collection of information regarding wild pig impacts, but often leave out events that are difficult to observe or hard to quantify (Jori et al. 2017). Brook and McLachlan (2008) demonstrated much value in the use of local knowledge in wildlife research. The use of questionnaires and social sciences has proven to be useful to assess the interactions between social and biophysical systems, and characterize the attitudes of the public towards environmental issues (Jori et al. 2017). Indeed, Beasley et al.

(2018) identified human dimensions as one of four research priority areas for wild pigs in North America.

Effective wild pig management requires that managers have a comprehensive understanding of issues, motivations and concerns from the perspective of stakeholders and the public (Massei et al.2011). Our objectives in this study were to (1) determine rural Canadian understanding of the presence of wild pigs in their region, (2) determine if the known distribution of wild pigs in each province was positively correlated with the perceived awareness of rural Canadians regarding wild pig presence, and (3) characterize the attitudes of rural Canadians toward the risks of wild pigs and the need for management efforts, and. We predicted that levels of concern and support for control efforts would be highest in provinces with the most extensive distribution of wild pigs. We predicted that awareness of wild pig presence would be highest in provinces with the most extensive areas occupied by wild pigs. We predicted that rural Canadians would have moderate to low levels of concern regarding existing or potential wild pig impacts as they are non-existent, newly emerging, or relatively recently established in all provinces in Canada.

STUDY AREA

Our study area included the rural areas of all ten Canadian provinces, encompassing an area of 6,062,951 km² (Statistics Canada 2011). The country was stratified by province and then further stratified by Canada Post Forward Sortation Area's (FSAs) within each province, based on the Canada Post definition of a rural area. The study area transitions across Canada from the Pacific Maritime ecozone on the west coast to the Atlantic Maritime ecozone on the east coast (Table 1). The study area is comprised of extensive agricultural cropland, deciduous and coniferous forests,

grasslands, wetlands, and montane ecosystems. The human population in rural areas across the Canadian provinces totaled 6,282,649 people, with an average overall human density of 1.04 people/km² (Statistics Canada 2011, unpublished data).

Wild pigs are established in all Canadian provinces except in the farthest east in Atlantic Canada (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador) (Table 1). The majority of wild pigs are found in agricultural areas across the three Prairie Provinces of Alberta, Saskatchewan, and Manitoba. The spatial distribution of wild pigs in Canada has been mapped in detail at the level 9 watershed scale by Aschim and Brook (2019). There are currently no population estimates or numbers of annual harvest recorded. Sport hunting of wild pigs across Canada is regulated differently in each province under agriculture and/or environmental policies, with most provinces allowing sport harvest.

METHODS

Survey Design

We conducted a telephone survey of rural Canadians based on a stratified random design (survey available online in Supporting Information). The sample size target for the number of respondents in each province was based on a stratified design that scaled to each provinces rural population size. Contact information was randomly selected from within the Canada Post FSAs. The target population for this survey was one individual from each household that was at least ≥18 years of age and was having the next birthday. The survey sample population excluded residents of the Yukon, Northwest Territories, Nunavut as there are currently no known occurrences of wild pigs in these three territories (Aschim and Brook 2019). The total number of

households the survey aimed to reach was 3000. If the household reached declined to participate or were unreachable, another household was called in their place. Survey interviews were completed during February and March of 2016, to utilize the time of the year that rural residents tend to be the most accessible. Survey data were collected by the Social Science Research Laboratory call center at the University of Saskatchewan. Survey participants were given the option of responding in either French or English, and French responses were translated by individuals that were fluent. The survey instrument included questions based around several themes, but for the purpose of this paper we examined the questions that included: perceived knowledge of wild pig presence in the area of the respondents, attitudes toward wild pig presence, risks, impacts, and need for management action. Survey participants were asked to give a score of 1 (no concern) to 5 (high concern) to the question: Wild boar presence in your province is a critical current concern. The remainder of the questions examined in this paper used a scale of 1 (Strongly disagree) to 10 (Strongly agree). Participants were also given the option to refuse the question or to answer, "I don't know". They were asked to provide their postal code in order to spatially reference each respondent. Participation was optional, participants were reminded they could end the interview at any time, and all aspects of survey design and implementation were approved by the University of Saskatchewan Behavioural Research Ethics Board protocol BEH 15-155.

DATA ANALYSIS

Rural Canadians responses to survey questions that related to questions regarding risks, impacts and perceived need for management were summarized and mapped. We compared the known

area of each province occupied by wild pigs (from Aschim and Brook 2019) to the % of respondents from the survey in each province indicating they were aware of wild pigs in their area using regression analysis.

RESULTS

Our findings indicate a range of knowledge and concerns about wild pigs in rural Canada and importantly, a low level of knowledge of the presence of wild pigs in each province, even where they are already widespread and abundant. Overall 9% (SE $\pm$ 0.14) of rural Canadians were aware of wild pigs in their rural area, with 91% of rural Canadians responding that they were unaware of wild pig presence in their province. Participant awareness of wild pig presence varied considerably by province (Figure 1), and was closely linked to the known overall distribution of wild pigs in each province, with highest awareness in Saskatchewan (42% of respondents), Alberta (21%), and Manitoba (21%) and relatively low (<10%) of participant awareness of the presence of wild pigs in all other provinces where wild pigs are known to exist (all provinces excluding Atlantic Canada) (Figure 2). While Aschim and Brook (2019) did not detect wild pigs in the Atlantic Provinces (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador), 0.02% of residents did (most likely incorrectly) indicate that they were aware of wild pigs in their province. Follow up phone calls to all participants in Atlantic Provinces that indicated they had observed wild pigs in their province determined that none of the respondents provided confirmation of sightings when asked directly.

Overall concern regarding invasive wild pigs was significantly and positively associated with the area of distribution (km²) of wild pigs within the respondent's province. Of the respondents, Saskatchewan had the highest overall level of rural residents concern regarding crop damage, livestock predation/harassment, structural damage, environmental impacts, threat to native wildlife, disease transmission to wildlife and livestock, disease transmission to humans, and threats to human safety and well-being was low to moderately high, with average level concern on a scale of 1-10 to specific questions ranging from ($\bar{x}$ = 3.5 to 6.9, table 2). Across all provinces, Saskatchewan had the highest concern about all impacts and the lowest rates of concern were found in Atlantic Canada (Figure 3). There was no significant difference between the concerns of male and female respondents ($t = 2.1$; $df = 1392$; $p = 0.89$) regarding wild pig presence. There was no significant difference between male and female respondents ($t = 1.9$; $df = 1306$; $p = 0.87$) regarding the statement 'wild pigs should be eradicated from your province'.

DISCUSSION

Rural Canadians have highly variable awareness of the presence of wild pigs in their province and this is best explained by the actual distribution of wild pigs in Canada, with respondent awareness increasing with wild pig distribution. Level of concern of rural Canadians regarding invasive wild pigs indicates that they are largely unaware of wild pig presence in their province. Provinces that had a higher percent of respondents aware of wild pig presence, also had higher levels of concern regarding invasive wild pigs. Overall awareness regarding invasive wild pigs is highly correlated with overall distribution of wild pigs within the respondent's province. The provinces with the highest percent aware of wild pig presence in their province, also had the highest area occupied by wild pigs. Saskatchewan has over 150,000 square kilometers of land

occupied by wild pigs (Aschim and Brook 2019) and 40% of rural Saskatchewan residents are aware of this wild pig presence. In the Atlantic Provinces there are currently no recorded sightings or documentation of wild pig presence and subsequently there is < 1% of rural residents aware of wild pigs in their province. Since most rural residents are unaware of wild pig presence within their province, their feelings of concern over this invasive species are relatively low as they are unacquainted with the negative impacts wild pigs can produce. In contrast, other studies in the U.S. where wild pigs have been well established such as Illinois found relatively high levels of concern, with 73% of respondents agreeing that ‘feral hogs are a source of disease’, 12% of respondents agreeing that ‘feral hogs are not a threat to people’, and 84% of respondents indicating that ‘feral hogs should be eliminated wherever possible (Harper et al. 2016). In Texas where wild pigs are widespread and abundant throughout the entire state, 89% of study participants agreed that they were an agriculture pest, and 50% agreed that they are an economic liability (Adams et al. 2005).

When asked to respond to the statement “Wild pig presence in your province is a critical current concern” only 5% of respondents answered that they strongly agree. Over 60% of the respondents answered that they strongly disagree that wild pig presence is a critical current concern. If rural residents are unaware of wild pigs even being present in their province, it is highly unlikely that they will think that the presence of these pigs is a concern. Many rural residents may be unaware of wild pig presence in their province, even if a large area of their province is occupied by wild pigs. Wild pigs are highly elusive and often active at night, making them often difficult to detect (Stolle et al. 2015). Rural residents overall concern regarding crop damage, livestock predation/harassment, structural damage, environmental impacts, threat to

native wildlife, disease transmission to wildlife and livestock, disease transmission to humans, and threats to human safety and well-being were overall low to moderate. These concerns were the lowest in provinces where wild pigs occupy <10,000 km². Across all provinces, Saskatchewan had the highest concern about all impacts and the lowest rates of concern were found in Atlantic Canada. The higher levels of concern in Saskatchewan are correlated with the increased area occupied by wild pigs of 159,176 km². Since the area occupied by wild pigs in Saskatchewan is the highest, there is a higher probability that a rural resident in Saskatchewan would be aware of wild pig presence.

Although invasive wild pigs have been established in Canada since the 1990s (Aschim and Brook 2019), prior to this study, there was an overall limited understanding of rural attitudes, knowledge, and awareness of rural Canadians. Rural residents that have experienced damage caused by invasive wild pigs are more likely to have strongly agreed that wild pig management is necessary. The only previous study of rural attitudes about wild pigs was by Brook and van Beest 2014) that found rural municipal leaders had similarly overall low levels of concern regarding a range of risks and impacts, including damage to crop, pasture, and fences where >50% of respondents felt these impacts were never serious.

The results of our work provide useful data for efforts aimed at eradicating and managing wild pigs in Canada and provide essential insights to support in the event that Canada aims to develop international, national, and provincial management plans. Currently only Alberta has a wild pig management plan. The use of social sciences and questionnaires presents quantitative insights from the rural public so managers are able to create informed opinions and decisions to

best serve their individual needs. Social survey data have been used successfully for informing other controversial issues where potential for conflict is high (Brook and McLachlan 2006, 2009) and to evaluate diverse management options (Brook et al. 2012). Since rural Canadians are the ones who are or will be experiencing the impacts from invasive wild pigs, it is important to know their opinions and attitude. This data can be highly valuable for management efforts and helps to effectively engage rural residents in helping them better understand invasive species in their direct surroundings in ways that conventional scientific research and biological monitoring often fails to do (Devictor et al. 2010).

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Figure Captions

Figure 1. Awareness of rural Canadians in each province regarding the presence of wild pigs, as determined through a telephone survey with 3007 participants in February and March of 2016. Provinces include BC (British Columbia), AB (Alberta), SK (Saskatchewan), MB (Manitoba), ON (Ontario), QC (Quebec), and AC (Atlantic Canada, which includes New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador).

Figure 2. Rural Canadian awareness of wild pig presence in each province (as determined through a telephone survey with 3007 participants in February and March of 2016) was positively correlated with the known distribution of wild pigs in each province established using multiple social and ecological methods ($R^2=0.93$, $df=6$, $P=0.001$). Provinces include BC (British Columbia), AB (Alberta), SK (Saskatchewan), MB (Manitoba), ON (Ontario), QC (Quebec), and AC (Atlantic Canada, which includes New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador).

Figure 3. Average responses by rural Canadians with Canada Post within forward sorting area boundaries to the statement ‘wild pig management in your province is required based on responses to a telephone survey with 3007 participants in February and March of 2016.

Table 1. Ecozones occurring within the study area in each province of Canada.

Province	Ecozones	Percent Forest Cover	Current Area Occupied by Wild Pigs (km ²)
Alberta	Taiga Cordillera, Praire, Taiga Plains	58%	44,559
Atlantic Canada	Boreal Shield, Atlantic Maritime	44%	0
British Columbia	Montane Cordillera, Pacific Maritime, Boreal Cordillera	60%	5,147
Manitoba	Boreal Shield, Prairie, Taiga Cordillera, Taiga Shield	48%	38,863
Ontario	Boreal Shield, Hudson Plains	65%	8,790
Quebec	Boreal Shield, Taiga Shield	45%	4,968
Saskatchewan	Prairie, Taiga Cordillera, Boreal Shield, Taiga Shield	50%	159,176

* wild pig distribution from Aschim and Brook (2019)

391 Table 2. Attitudes of rural Canadians toward invasive wild pigs across all provinces. Answers are
 392 based on a telephone survey (n=3007 participants) conducted in February and March of 2016.
 393 Provinces include BC (British Columbia), AB (Alberta), SK (Saskatchewan), MB (Manitoba),
 394 ON (Ontario), QC (Quebec), and AC (Atlantic Canada, which includes New Brunswick, Nova
 395 Scotia, Prince Edward Island, Newfoundland and Labrador).

Statement	Province	% Disagree	% Neutral	% Agree	% I Don't Know
Wild pig presence in your province is a critical current concern.	BC	76	12	5	7
	AB	58	22	14	6
	SK	32	26	42	0
	MB	55	26	11	8
	ON	73	16	6	5
	QC	78	13	7	3
	AC	82	9	6	4
	Average	71	15	10	4
Wild pigs will become a large problem in your province in the future.	BC	69	16	8	7
	AB	48	23	19	10
	SK	22	22	48	7
	MB	75	11	8	6
	ON	62	20	10	8
	QC	66	19	10	5
	AC	62	18	10	10
	Average	60	19	13	7
Wild pig management in your province is required.	BC	50	22	17	12
	AB	35	23	29	14
	SK	16	16	60	8
	MB	26	31	25	18
	ON	55	20	15	11
	QC	52	19	24	5
	AC	69	11	12	8
	Average	49	19	22	9
Wild pigs should be eradicated from your province.	BC	58	19	17	6
	AB	45	23	28	4
	SK	23	22	52	3

MB	44	24	19	13
ON	58	20	15	6
QC	69	18	9	4
AC	61	16	14	9
Average	57	19	17	6

Table 3: Average levels of concern from respondents in each province regarding eight specific risks and impacts of invasive wild pigs in rural Canada. Answers are based on a telephone survey (n=3007 participants) conducted in February and March of 2016. Participants were asked to indicate their level of concern on a scale from 1 to 10, where 1= no concern, 5= moderate concern, and 10= extremely high concern. Provinces include BC (British Columbia), AB (Alberta), SK (Saskatchewan), MB (Manitoba), ON (Ontario), QC (Quebec), and AC (Atlantic Canada, which includes New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador).

Type of Impact or Risk Regarding Wild Pigs in Rural Canada ^a								
Province	Crops	Livestock	Structures	Environment	Wildlife	Diseases Animals	Diseases Human	Human Safety
AB								
(n=344)	5.4	4.7	4.5	4.9	4.7	5.1	4.5	4.7
AC								
(n=495)	3.7	3.6	3.1	3.4	3.6	3.9	3.6	3.3
BC								
(n=284)	4.0	3.5	3.2	3.9	3.9	3.9	3.2	3.2
MB								
(n=178)	5.7	5.2	4.9	5.1	5.2	5.7	4.9	5.2
ON								
(n=710)	4.5	4.1	3.6	4.2	4.2	4.5	3.9	3.9
QC								
(n=804)	4.3	3.8	3.4	3.6	3.9	4.1	3.8	3.7

SK

(n=189) 6.9 6.4 6.2 6.0 6.0 6.7 5.7 6.1

405 ^aSee questionnaire in the online Supporting Information for specific question wording