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Hunter and public opinions of a Columbian black-tailed deer population in a Pacific Northwest island landscape

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Abstract: Management decisions are influenced by public acceptance for wildlife; thus, knowledge of public concerns and management preferences can be an advantage to natural resource decision makers. Wildlife managers with the Washington Department of Fish and Wildlife are concerned that the Columbian black-tailed deer (*Odocoileus hemionus columbianus*; deer) population on Whidbey Island, Washington, USA, exceeds social carrying capacity (i.e., a publicly acceptable population). In summer 2014, we designed a self-administered mail questionnaire to assess opinions of residents and a phone survey to assess the opinions of Whidbey Island deer hunters about Columbian black-tailed deer. We hypothesized that residents would support increased hunting when social carrying capacity was exceeded. The resident survey focused on the frequency and type of interactions with deer, the level of acceptability of the population, and their willingness to support increased hunting. Residents perceived the deer population as acceptable for the island, and there was some support for increased hunting. The hunter survey focused on the respondents' experience hunting deer on the island, including their opinion of the current deer population trend and the desired future deer population trend. Hunters perceived the deer population trend to be increasing somewhat, while their desired population trend was stability. Hunters cited the lack of public and private land open to hunting on Whidbey Island as the biggest barrier and the most common complaint about hunting deer on the island. The results of these surveys suggest the deer population on Whidbey Island (n = 6.2 deer/km^2) had not exceeded social carrying capacity. There is support (62% of respondents) for increasing hunting opportunities on the island, but island residents were concerned about public safety. Understanding public views is instrumental for enhanced management. Managers and the public must work together to manage wildlife resources more effectively.

Key words: Columbian black-tailed deer, hunting, *Odocoileus hemionus columbianus*, public opinion, social carrying capacity, Washington, Whidbey Island

Deer (Cervidae) overabundance has been acknowledged in localized areas of the United States for >60 years, and the rise of public involvement in deer management has spurred research on the interaction of high deer densities and humans (Leopold et al. 1947, Warren 1997, Krausman et al. 2014). Research has focused on determining the social carrying capacity (i.e., a publicly acceptable population) for deer in an area, and how receptive the community is to different management options (Decker and Gavin 1987, Loker et al. 1999, Carpenter et al. 2000, Urbanek et al. 2012). Much of the research on the interactions between overabundant deer populations and humans in the United States comes from the Midwest and East Coast concerning white-tailed deer (*Odocoileus virginianus;* VerCauteren and Hygnstrom 2011, Hewitt 2015). There have also been overabundance issues with Columbian black-tailed deer (*O. hemionus columbianus*; McCullough et al. 1997).

In California, USA, researchers report communities and wildlife management agencies struggling to reduce deer populations with little success (McCullough et al. 1997). Around Vancouver, Washington, USA, researchers reported lower deer abundance and densities in urban and suburban areas than neighboring rural areas (Bender et al. 2004*a*, *b*). These researchers observed higher reproductive levels in urban and suburban deer, leading to the

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possibility of an overabundant deer population.

Increasingly, wildlife management is more about managing humans than managing wildlife (Decker and Chase 1997, Riley et al. 2002). Often, management is predominantly influenced by the public's level of acceptance for a wildlife species (Riley and Decker 2000, Riley et al. 2002). For example, a recent survey of deer biologists across the United States reported that the acceptance for overabundant deer populations was social and not biological (i.e., populations are balanced with habitat components; Krausman et al. 2014). Additionally, the level of public acceptance for a species can range from adoration to hatred, within and among communities (Decker and Purdy 1988). As communities seek more active involvement in the management of their natural resources, several methods of inclusion have arisen, from approaches that require consensus between interested parties on management actions to community votes on proposed management alternatives (Stout et al. 1996, Kilpatrick and Walter 1997, Schusler and Decker 2002).

Urban and suburban residents, however, can have different views toward wildlife than rural residents, often preferring to trap and remove deer or attempt contraceptive efforts instead of lethal removal (McCullough et al. 1997, Messmer et al. 1997, Stout et al. 1997, Warren 1997). Safety concerns to humans from hunting (i.e., types of weapons used) are another reason the public may view hunting as negative (Duda and Jones 2009). This wide range of acceptance for species and management methods can lead to difficulty accomplishing or even determining deer management goals (Messmer et al. 1997).

As the public seeks a more active role in managing wildlife, knowledge of public opinions about wildlife becomes more important (Kilpatrick and LaBonte 2003). Wildlife values are important because they form the basis of people's attitudes toward an object, in this case wildlife, and behavioral intentions toward participating in wildlife-associated activities (Fulton et al. 1996, Teel et al. 2007, Teel and Manfredo 2009). By assessing where an individual or group within a community falls on a multi-dimensional spectrum of wildlife rights, use versus non-use, and societal and ecological benefits, researchers can better predict public responses to proposed management actions involving wildlife (Purdy and Decker 1989, Teel et al. 2007). Wildlife value orientations group individuals into 4 categories: utilitarian (i.e., human-dominant view of interacting with wildlife), pluralist (i.e., a mix of utilitarian and mutualist views), mutualist (i.e., support animal rights, anthropomorphize wildlife, and object to lethal management actions), and distanced (i.e., not interested in wildlife or wildlife issues, express general fear of wildlife, and have limited interactions with wildlife in their lives; Teel and Manfredo 2009, Dietsch et al. 2011). Researchers suggest utilitarians and pluralists are from similar demographic groups and share lifestyle characteristics, such as being more likely to be male, slightly older, and to reside in the same state for longer (Dietsch et al. 2011).

To improve their knowledge about public opinions toward wildlife, the Washington Department of Fish and Wildlife (WDFW) commissioned a statewide survey on the public's wildlife value orientations (Dietsch et al. 2011). According to the 2011 study, Island County, which included Whidbey and Camano islands, had a higher proportion of distanced residents than neighboring counties in Washington (Dietsch et al. 2011). Also, Dietsch et al. (2011) concluded there were approximately one-third more utilitarians than mutualists in Island County. This contrasted with neighboring counties where there was a more even distribution of utilitarians and mutualists. The uneven ratio of utilitarians to mutualists in Island County suggested more public acceptance of traditional management techniques, which tend to focus on lethal management actions. Finer-scale information, however, is needed for managers to gauge the opinions of Whidbey Island residents and deer hunters of the island toward deer and hunting in particular.

Biologists with the WDFW were also interested in how deer hunters perceived the deer population on Whidbey Island. The WDFW requires after-hunt reporting of success or failure and hunter effort via a call or by completing a survey on the WDFW website. Hunt effort and success are used to inform biologists on the status of big game populations by providing information on the number of animals harvested, where the animals were harvested, and how

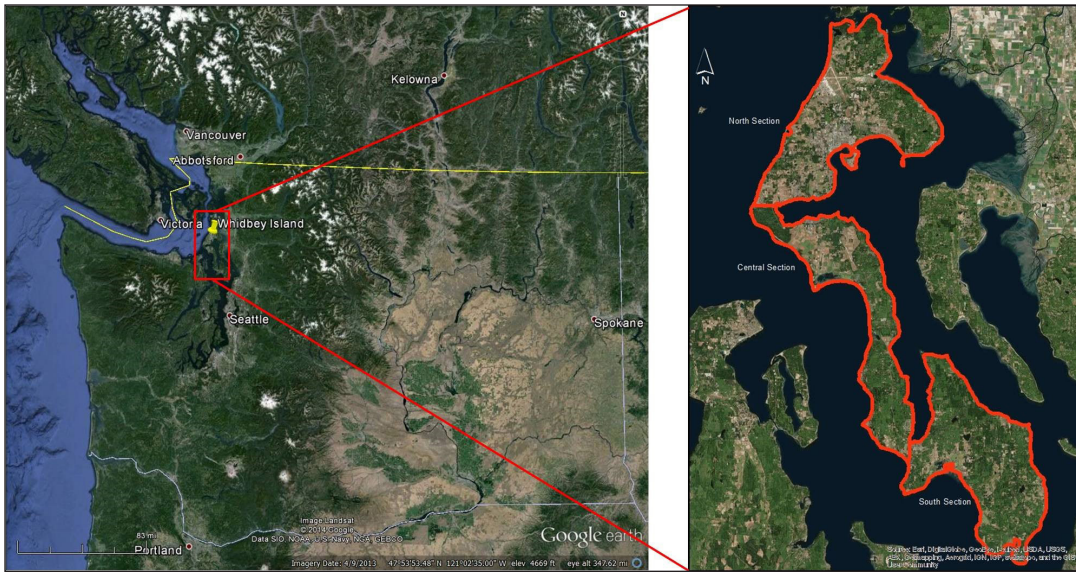

Figure 1. Whidbey Island, Washington, USA. For the purposes of this study, the island was divided into 3 sections: north, central, and south.

much hunting effort occurred in each game management unit (GMU).

Prior to 2013, Whidbey Island was combined with Camano Island and all of San Juan County, which included 128 separately named islands, into 1 GMU. Thus, specific numbers from Whidbey Island were not available. In 2013, the GMUs in the region were reorganized and Whidbey Island became a single GMU, but it was not until 2014 that reliable information was available for Whidbey Island as an isolated area (R. Milner, WDFW, personal communication). From the 2014 after-hunt reporting, the reported harvest was 293, with 208 antlered deer and 85 antlerless deer. The lack of historic harvest data combined with the lack of a population estimate for deer on Whidbey Island makes it difficult to determine the effects of harvest on the deer population on Whidbey Island.

Concern about Columbian black-tailed deer overabundance and high density on Whidbey Island is not a new phenomenon. Deer were perceived to be so abundant from the 1930s to the late 1950s that there were attempts to eliminate them from Whidbey Island to protect the strawberry (*Fragaria* spp.) crop (Zem and Wells 1955). This perceived high abundance followed a period of intense, industrial logging on the island leading to more beneficial forage conditions for deer (Brown 1961, Smith 1968, Kremsater and Bunnell 1992, White 1992). This attempt at eradication was unsuccessful, but 400–600 deer were harvested annually for 18 years to alleviate the crop damage they caused (WDFG files, Island County, Washington). Although negative deer–human interactions continue, over the last decade, deer–vehicle collisions occur up to 150 times annually (R. Milner, WDFW, personal communication), which influences the population. Additionally, WDFW has increased hunting opportunity on Whidbey Island by offering a second antlerless tag to hunters in recent years.

Hunting is a primary wildlife management tool, and often the first option attempted to reduce overabundant ungulate populations (Simard et al. 2013, Weckel and Rockwell 2013, Williams et al. 2013). The use of hunting by state wildlife management agencies makes the agencies effective at and comfortable designing hunting seasons to reduce deer populations (Heffelfinger et al. 2013). There are, however, many confounding variables that can limit the effectiveness of hunting as a tool to control overabundant ungulates (e.g., access, public opinions, limitations on weapons, limitations on take).

Foremost among these variables is limited hunting access (DeNicola et al. 1997). The reduced access for hunting leads to a reduction in the effective area of population reduction, often to the point that the strategy is ineffective (Simard et al. 2013, Weckel and Rockwell 2013,

Williams et al. 2013). Concerns about public safety can be a limiting factor for landowners allowing access as well as support from the general public (DeNicola et al. 1997). On Whidbey Island, there is limited public access to hunting, and what land is open to hunting often has restricted seasons to accommodate other recreational users (e.g., hiking, cycling, bird watching).

Knowledge of the potential limiting factors for different population management techniques provides management agencies with more information regarding likelihood of success of a given management technique. It can be important for managers to acknowledge the differences in deer population preference between hunters and the general public, as they have different purposes (e.g., aesthetics, meat, recreation, utilitarian; Duda and Jones 2009, Urbanek et al. 2013).

We designed a 2-part study to assess the opinion of the human population of Whidbey Island toward the Columbian black-tailed deer loosely based on the social-ecological system of determining opinions (Anderies et al. 2004), which are influenced by complex and often nonlinear dynamic and external processes (e.g., resource users, resources, public infrastructure; Roe 1998).

The first portion of the study is a self-administered mail questionnaire of residents of Whidbey Island designed to determine the level of acceptability of the deer population for different regions of the island and opinions on deer management strategies. The second portion of the study is a phone survey of hunters who reported hunting Whidbey Island in 2014. The phone survey was focused on hunter opinions on deer population size, population trend, and hunting access on Whidbey Island. We predicted that respondents would generally support increased hunting on Whidbey Island because Dietsch et al. (2011) reported high rates of utilitarian wildlife value orientations in Island County, suggesting more acceptance by the public of traditional management methods, including hunting. We also predicted respondents' opinions toward deer would not vary by deer population density in their region, as recent research has suggested opinions toward deer do not change with varying deer density (Urbanek et al. 2013).

Study area

Our study area was on Whidbey Island, northwest Washington (Figure 1) and is described by Wingard (2015) and Wingard et al. (2019). The topography of Whidbey Island is devoid of large mountain or continuous steep slopes, except for the coastline, where there are large bluffs. We divided the island into 3 sections: north (166 km^2), central (122 km^2), and south (152 km^2). We separated the island because the 3 sections have different human demographics (Table 1).

There is very limited public hunting access, and the lands open to hunting for the public are often restricted to a limited season by the landowners to accommodate other land uses such as hiking, bicycling, and horseback riding. Large tracts of land open to the public generally consist of small county-owned properties, a Washington State Department of Natural Resources property on the southern section of the island, and a property owned by the Whidbey Camano Land Trust on the central section of the island. Additionally, there are hunting opportunities on the Department of Defense-owned land for military servicemen and their guests. Additional information about the study area is presented in Wingard (2015) and Wingard et al. (2019).

Methods

Public opinion survey

Participants. We randomly selected recipients for the survey using Survey Sampling International (San Francisco, California, USA). Survey Sampling International selected a random sample of adult residents from all homes on Whidbey Island and provided us with a proportional list of 2,000 residents representative of the 3 sections of the island that we contacted for the survey, sampling roughly 3% of the population.

Survey instrument. Public opinion mail surveys are more representative than public meetings or advisory groups and provide objective information (Johnson et al. 1993, Peterson and Messmer 2010). We based survey questions on input from WDFW personnel and adapted from the literature, beyond basic demographic information such as age, sex, occupation, property size, and tenure in the region (Wingard 2015) to address our goal of

Table 1. Population and housing statistics for Whidbey Island, Washington, USA, separated by region. Data obtained from U.S. Census Bureau (2010).

Region	Population	% of total population	Housing	% total housing	% occupied	% owner occupied	% renter occupied	% with minors	% vacant	% occasional use
Island-wide	62,845	100	31,749	100	79.86	56.72	23.14	20.59	20.13	0.20
North	36,757	58.49	15,777	49.69	90.07	51.51	38.56	31.01	9.93	0.25
Central	12,458	19.82	7,281	22.93	76.97	62.01	14.96	15.75	23.03	0.148
South	13,630	21.69	8,691	27.37	72.56	56.64	15.91	15.02	27.44	0.22

estimating the views of the public and hunters about deer on Whidbey Island. We sent the survey instrument to 10 WDFW biologists and human dimension survey experts from the University of Montana and refined it based on their input. We adapted questions about respondent opinions of the acceptability of the deer population from Urbanek et al. (2012) and used a 5-point rating scale from not acceptable to very acceptable with a fifth option, N/A, for those unfamiliar with a given island section (i.e., north, central, south). We used a self-administered mail questionnaire to determine the opinion of island residents ≥18 years old toward deer, their preference on deer population trend, and opinions on hunting. We designed the survey to maximize the response rate following the Tailored Design Methods outlined in Dillman (2007).

We asked 23 questions about the frequency of various deer–human interactions (e.g., deer–vehicle collisions, consumption of crops and landscaping [negative interactions], and the frequency of overall negative interactions with deer on a scale of weekly to yearly). We asked additional questions about hunting deer on Whidbey Island, focusing on whether the respondent allowed hunting on their property and if no then why, whether they would be willing to allow hunting under certain conditions, and if they would be willing to support increased hunting if it reduced deer–vehicle collisions. We also asked general information (i.e., location of the respondent's home, whether they rented or owned their home, length of residency) and personal information (e.g., gender, birth date, occupation).

We sent an initial contact letter in July 2014 informing the recipients they were randomly selected for this survey, about the subject of the survey, and the importance of their response (Wingard 2015). If the U.S. Post Office returned an initial contact letter with a new address, we used that address. A week to 10 days after the initial letter, a follow-up survey questionnaire (Wingard 2015) was sent with a stamped and addressed return envelope. Two weeks after the survey, we sent a reminder postcard to individuals who had not returned the survey. We excluded letters returned as undeliverable or returned to sender from the sample. Following Dillman (2007), we used postage stamps and

stuffed and addressed the letters personally, so the envelope looked like it was put together by a person instead of a computer to increase response rates. We numbered surveys to maintain the anonymity of respondents and placed them in envelopes to identify the addresses that returned surveys. We recorded returned surveys into a database.

Response rates are influenced by level of interest in the topic addressed (Dillman 2007). Previous research on the wildlife value orientations of people in Washington indicated Island County had the highest proportion of distanced individuals of any county in the state with 27% of respondents falling in the distanced category (Dietsch et al. 2011). Recent studies on white-tailed deer in the Chicago Metropolitan Area reported a response rate of 34%, with fewer than half the number of useable surveys that this study received (Urbanek et al. 2012, 2013, 2015). Also, Baruch (1999) reported response rates as low as 36.1 ±13.3 (SD) for some academic studies. Additionally, the Chicago Metropolitan Area studies reported very minor non-response bias, similar to the small differences observed in this study between immediate responses and responses after the third contact (i.e., a proxy for non-response rates; Urbanek et al. 2012, 2013, 2015). Additionally, when examining responses for differences between early and late respondents, there was no substantive difference between them, only slight demographic differences with late respondents being younger and having lived on the island for less time. We used the proxy non-response rate in lieu of conducting an evaluation non-response bias due to funding and timing limitations. Considering this information, we suggest the response rate of the self-administered mail questionnaire of 36% was sufficient to draw conclusions but recognize the lack of a formal non-response check may bias our work.

Data analysis. We compiled summary statistics on the responses. We grouped the respondents based on island location to identify views on deer and hunting on the island. We then evaluated public opinions toward deer population size and potential management actions. We performed all statistical analysis using Program R 2.15.2 (R Core Development Team 2014). We used the method of analysis for comparison of means (i.e., 1-way analysis of variance with Tukey pair-wise comparison to determine the level of acceptability of the deer population to the public on the 3 different regions of the island and their opinions on deer management strategies).

Hunter survey

Participants. We used contact information provided by WDFW, WDFW Master Hunter volunteers, and conducted phone surveys of deer hunters in March 2015 who reported hunting on Whidbey Island in 2014 (i.e., the most recent year from which we could obtain hunter information). Of the 411 individuals who reported hunting on Whidbey Island to WDFW, 92% had phone numbers recorded in the WDFW database. We randomly selected 50 of these individuals (12% of the deer hunters on Whidbey Island); none of them had received the mail survey.

Survey instrument. We developed survey questions with input from WDFW personnel and questions adapted from the literature (Wingard 2015). All volunteers received phone training so all those questioned would receive information delivered in a consistent manner. Questions on method of take and harvest success were adapted from Duda et al. (2014). Survey questions on the current and desired deer population trend were adapted from Curtis and Lynch (2001). Questions on barriers and constraints to hunting were adapted from Barro and Manfredo (1996) and Metcalf et al. (2015).

We asked hunters 23 questions that took ≤15 minutes to answer. We used a phone survey instead of a self-administered mail questionnaire because phone surveys were faster and more economical for the smaller sample size (Dillman 2007). The sampling scope was influenced by a lack of, or erroneous, contact information; no contact information was available for some hunters (these hunters were not included in our analysis as there is no way to contact them), and >8% of hunters did not include a phone number in their contact information or had incorrect phone numbers. We placed the phone calls between 1800 and 2100 hours. Individuals selected to participate in the survey were contacted ≤3 times if there was no answer to attempt to increase response rate.

The survey focused on residency of hunters

Table 2. Frequency that survey respondents experienced Columbian black-tailed deer (*Odocoileus hemionus columbianus*; deer) interactions for different human–deer interactions (i.e., deer–vehicle collisions, deer damage to landscape, deer crop depredation), Whidbey Island, Washington, USA, 2014.

Data selection	Deer vehicle frequency[a]	*P*-value	Deer landscaping frequency[a]	*P*-value	Deer crop frequency[a]	*P*-value
Island-wide	2.39		2.805		2.448	
North	2.234	Reference[b]	2.329	Reference[b]	2.117	Reference[b]
Central	2.512	$P = 0.0691$	3.246	$P < 0.0001$	2.524	$P = 0.0336$
South	2.511	$P = 0.0349$	3.054	$P < 0.0001$	2.809	$P < 0.0001$
Before reminder	2.367	n	2.816	n	2.49	n
After reminder	2.443	n	2.679	n	2.343	n
Hunter	2.597	n	2.974	n	3.429	n
Non-hunter	2.358	n	2.96	n	3.19	n

[a] 1 = never, 2 = rarely, 3 = occasionally, 4 = regularly
[b] When comparing the different groups of respondents, the data selection group was selected as the reference to determine any differences between the groups.

(i.e., residents and non-residents of Whidbey Island), how hunters gained access to the properties they hunted, their success rate, harvest method, personal information, and opinion of the status of deer on the island (Wingard 2015). We also asked what they perceived as barriers to hunting and management they would like to see implemented; these were open-ended questions.

Data analysis. We calculated summary statistics and evaluated hunter opinions on the size of the deer population and potential management actions. Additionally, we compared the responses of hunters to the responses of the general public on the island. The comparison should shed light on the issues that may arise as managers attempt to balance the desires of hunters with the desires of the other residents of Whidbey Island. All statistical analysis was performed using Program R 2.15.2 (R Core Development Team 2014). This study was approved by the Institutional Review Board, University of Montana (IRB # 47-14).

Results

Public opinion survey

Of the 2,000 initial addresses, 1,637 were valid; 363 questionnaires were undeliverable. Our overall response rate was 36% (595 responses). The 595 respondents answered 60–100% of the questions.

The north, central, and south sections of the island returned 256, 135, and 202 responses, respectively. The proportion of survey respondents from each section was not proportional to the housing statistics for each island section (Table 1).

The average age of respondents was 58.7, 65.0, 67.2, and 61.5 in the north, central, south, and island-wide groups, respectively. When compared using 1-way analysis of variance with Tukey pair-wise comparison, the average age for the north section was lower than the south and central regions ($P = 0.0123$, $P < 0.0001$, respectively). The proportions of respondents by gender were 58% male, 41% female, and 1% joint reporting. By island section, the north section had an average of 1.34, more unevenly represented with more males than females, while the central and south sections had more evenly divided gender responses. Overall, the gender of those responding to the public survey were similar ($P = 0.09$) for the island. Respondents who indicated they were retired accounted for 50% of the respondents. Military personnel accounted for 17.6%,

Table 3. Mail survey respondent opinions on Columbian black-tailed deer (*Odocoileus hemionus columbianus*; deer) population sizes based on region, and respondent's willingness to support increased hunting, Whidbey Island, Washington, USA, 2014.

Data selection	North Whidbey deer population[a]	*P*-value	Central Whidbey deer population[a]	*P*-value	South Whidbey deer population[a]	*P*-value	Frequency negative interaction with deer[b]	*P*-value	Support for increased hunting[c]	*P*-value
Island-wide	3.11		3.01		3.36		2.85		1.97	
North	3.16		3.16	Ref[d]	3.72	Ref[d]	3.05	Ref[d]	2.2	
Central	2.93		2.83	$P = 0.05$	3.26		2.72	$P = 0.03$	2.24	
South	3.10		3.09		3.05	$P < 0.01$	2.71	$P = 0.09$	2.1	
Before reminder	3.12		3.06		3.36		2.82		2.16	Ref[d]
After reminder	3.04		2.83		3.23	2.82			2.35	$P = 0.07$
Hunter	2.80	Ref[d]	2.96		3.07	Ref[d]	2.72		2.75	Ref[d]
Non-hunter	3.173	$P = 0.02$	3.02		3.42	$P = 0.03$	2.87		2.07	$P < 0.01$

[a] 1 = not acceptable, 2 = somewhat acceptable, 3 = moderately acceptable, 4 = very acceptable
[b] 1 = weekly, 2 = monthly, 3 = yearly, 4 = never
[c] 1 = not at all willing, 2 = somewhat willing, 3 = very willing
[d] When comparing the different groups of respondents, the data selection group was selected as the reference to determine any differences between the groups.

business accounted for 9.3% of the occupations, forestry 1.4%, and other options (i.e., education, health, construction, farming, other) accounted for <5% each. Most survey respondents own their home (85%). Whether respondents owned or rented their homes differed across regions and the whole island ($P = 0.014$). This suggests underrepresentation of island residents who reside in rental properties (Table 1). This was expected because survey letters were likely to have the wrong names for renters because we only obtained the names of owners. Also, the majority of residents island-wide had lived on Whidbey Island for >5 years; there were no differences between the 3 regions (Wingard 2015).

Encountering deer on roads was common on the island. Most respondents (64%) reported a near miss between deer and vehicles. Respondents on average reported they rarely experience deer–vehicle interactions (Table 2). This varied by island section (Table 2). Respondents on average reported they occasionally experience interactions between deer and landscaping. This varied by island section (Table 2). Respondents on average reported they rarely experience interactions between deer and crops. This varied by island section (Table 2).

The acceptance of deer on the island varied by region ($P < 0.001$). Respondent opinions on the acceptability of the number of deer on the north section of Whidbey Island was rated as moderately acceptable (Table 3). However, 254 respondents did not answer the question or indicated they were not familiar with deer in the north section. Respondent opinions on the acceptability of the number of deer on the central section of

Whidbey Island also averaged to moderately acceptable (Table 3). Again, there were high levels of non-response with 287 respondents not indicating an answer or indicating a lack of knowledge of deer in the central section. Island section differed by respondents' support for increased hunting ($P = 0.044$; Table 3).

Respondents in the south section of Whidbey Island were moderately acceptable of deer. There were lower levels of non-response than the other regions at 114. We attributed this to the layout of the responses on the survey. Respondents from the north section of the island responded differently than the central or south sections ($P = 0.007$, $P < 0.001$, respectively), on average suggesting the deer population on the south section was very acceptable, whereas residents of the central and south portions of the island indicated the population was moderately acceptable. Acceptance of the deer population was not related to gender in the north, central, or south ($P = 0.179$, $P = 0.433$, $P = 0.276$, respectively) portions of the island.

The north section of the island reported less frequent negative interactions with deer than either the central or south sections ($P = 0.03$, $P = 0.009$, respectively; Table 3). There was no difference by island section for whether respondents supported increased hunting on Whidbey Island (Table 3). Overall, respondents ($n = 543$) were somewhat willing to support hunting on Whidbey Island if it reduced the number of deer killed in deer–vehicle collisions (Table 3). Of those who did not respond to this question ($n = 52$), 45% were very willing to support increased hunting on the island, 28% were somewhat willing, and 27% were not at all willing. Respondents from the central section were slightly more inclined to increasing hunting options than respondents of the north or south regions, who were only somewhat supportive of increased hunting options (Table 3).

Respondents who returned the survey after the third contact were more inclined to be very willing to support increased hunting on Whidbey Island; however, the average response was still somewhat willing to support hunting ($P = 0.0727$; Table 3). Support for increased deer hunting on Whidbey Island was highly correlated with frequency of negative interactions with deer ($r = 0.42$, $P < 0.0010$).

The most common response to the question of why a respondent does not allow hunting was "property is too small or too close to other homes" (72% of respondents), followed by "it would not be safe" (36% of respondents). Other common responses included "do not agree with deer hunting" (17.7%), "liability concerns" (11.5%), "conflict with other land uses" (8%), and finally, "other" (7%). Respondents who selected "other" often indicated that while they lived outside city limits the covenants or homeowner association rules for the area they lived prohibited hunting. Very few respondents allowed hunting on their property; 6.5% of respondents allow hunting compared to 85% who do not. Of those that do allow hunting on their property, 47.7% allow family and friends only, and 20% allow any licensed hunter who asks.

Hunters represented 14% of mail survey respondents. They were more supportive of increasing hunting on Whidbey Island than non-hunters, with an average response of very willing to support increased hunting if it reduced deer–vehicle collisions ($P < 0.001$). Hunters thought the deer population in the north section of the island was less acceptable than non-hunters, though average response was the same ($P = 0.0193$). Hunters did not differ from non-hunters in the acceptability of the deer population of the central section of the island. Hunters thought the deer population in the south section of the island was significantly less acceptable than non-hunters ($P = 0.0324$), though the average response remained the same. Hunters experienced similar frequencies of negative interactions with deer (Tables 2 and 3).

Hunter survey. We achieved a sample size of 50 hunters by calling 126 hunter phone numbers 221 times. Of the 126 phone numbers attempted, 30 were no longer in service or reached the wrong person. Of the 50 hunters reached, 9 declined to take the survey, for a non-response rate of 18%. None of the hunters in the phone interview were sent a mail questionnaire.

Most hunters who participated in the survey lived on Whidbey Island (65%). Most of those lived in the north section of Whidbey Island (46%), while the remaining hunters were evenly divided between the central and south sections. Most respondents were male (87.5%). The average age of respondents was 40 years old, with a range of 14 to 78. Most hunters used shotguns to pursue deer (66.6%), the second

Table 4. Hunter opinions from phone survey on Columbian black-tailed deer (*Odocoileus hemionus columbianus*; deer) population status and trend on Whidbey Island, Washington, USA, 2015, separated by island section, residency of hunter, and method of harvest of hunter.

Data selection	Whidbey population trend[a]	Whidbey population wish[b]	North Whidbey trend[a]	North Whidbey wish[b]	Central Whidbey trend[a]	Central Whidbey wish[b]	South Whidbey trend[a]	South Whidbey wish[b]
All	4	2.7	3.931	2.706	3.828	2.677	3.839	2.71
Resident	4.12	2.846	4.048	2.875	3.95	2.762	3.95	2.8
Non-resident	3.79	2.429	3.625	2.3*	3.55	2.5	3.636	2.545
Modern	4.037	2.593	3.8	2.583	3.842	2.526	3.866	2.571
Archery/ muzzleloader	3.75	3	3.9	3.167	3.714	3	3.857	3

[a] 1 = drastically decreasing, 2 = somewhat decreasing, 3 = stable, 4 = somewhat increasing, 5 = drastically increasing
[b] 1 = drastically decrease, 2 = somewhat decrease, 3 = remain stable, 4 = somewhat increase, 5 = drastically increase
* Determined from analysis of variance; $P = 0.067$

most popular method of take was archery (22%). These were followed by muzzleloader, handgun, and crossbow (6.7, 2, and 2%, respectively).

Most of the respondents reported harvesting deer on Whidbey Island in the last 5 years (70%). The years they reported harvesting deer showed more harvest in more recent years. Most hunters hunted on private property (90%). The landowners were predominantly family members or friends (39%, 36%, respectively). The majority of hunters were invited to the property they hunted (78%), with hunters asking permission before the season or directly before the hunt, accounting for 11% each.

Like the mail survey of Whidbey Island residents, many hunters indicated they were unfamiliar with certain areas of the island, leading to varying rates of non-response for the 3 sections of the island. Overall, however, all deer hunters reported that Whidbey Island deer populations were somewhat increasing and would like to see these populations remain stable (Table 4). The survey respondents from all sections of the island were similar in their opinion of the population trend ($P = 0.867$).

Limited access to private lands was perceived by respondents to be the largest barrier to hunting and the most common complaint about hunting on Whidbey Island. The respondents were generally split on whether they were aware of the Washington State Private Lands Program (47% aware, 52% unaware), but 90% of the respondents supported expanding the program on Whidbey Island. Hunters (27%) cited local community resistance to hunting on Whidbey Island as a barrier. Other barriers to hunting were selected by ≤5% of respondents. The most commonly reported of these was restricted method of harvest (5%).

Discussion

Respondents were more likely to indicate deer populations were acceptable for sections of the island where they did not live. The exception to this was the north section, where respondents indicated a higher acceptability of the deer population for that section than respondents from other sections (Table 3). The northern section of the island is much more urban than the other sections of the island, with much smaller average land parcel size. Wingard et al. (2019) reported a deer density of 5.2 deer/km^2, but rarely observed deer in Oak Harbor city limits. Other researchers have observed lower Columbian black-tailed deer densities in urban areas than suburban and rural areas, with few exceptions (Happe 1982, McCullough et al. 1997, Bender et al. 2004*b*). With fewer deer where many people in the north section live, there are fewer opportunities for deer–vehicle accidents, landscape damage, and crop damage.

The central and south sections varied in their opinion on the acceptability of the deer population by section, with other sections

having more acceptable deer populations than the respondent home section. The south section was very consistent in its response that the deer population across all sections of Whidbey Island was somewhat acceptable even though both central and south sections had similar rates of negative interactions with deer (Table 2).

We observed higher rates of hunting participation for Whidbey Island than Dietsch et al. (2011) reported for Island County as a whole. This may indicate substantially lower rates of hunting participation on Camano Island, the other region included in Island County. Additionally, the hunter survey observed slightly higher female hunting participation rates than the nationwide average (11%), and a much higher female deer hunting participation rate than the statewide average (4%; Duda et al. 2014; U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2018). Black et al. (2018) reported that females were motivated to hunt for social interactions, meat, and to experience nature.

The rates of use for different methods of deer harvest on Whidbey Island differed from the statewide rates (Duda et al. 2014). This is expected as there is a firearm restriction on Whidbey Island (i.e., high powered rifles are not allowed to hunt deer). As a result, some hunters may not be interested in hunting on the island. There were, however, similar trends between Whidbey Island and statewide hunters. Duda et al. (2014) reported that modern firearms (85%, including rifles, shotgun, handgun) were the most commonly used equipment, followed by archery (18%), muzzleloader (11%), and shotgun (6%). The research from Whidbey Island suggests that even with firearm restriction, hunters prefer hunting in the modern firearm season using shotguns, handguns, and crossbows (70%) over muzzleloader or traditional archery equipment (28% combined).

Although there were differences in survey methodologies between the hunter and public surveys, direct comparisons could be made. The response of hunters to the deer population on Whidbey Island was similar to the response of the general public ($P = 0.244$). The general public described the deer population on average to be moderately acceptable, and deer hunters preferred that the population trend for deer of all sections of Whidbey Island remain stable. This finding is similar to research from Maryland, USA, which reported preference for deer populations to remain the same across a sample of the general public, hunters, and farmers (Curtis and Lynch 2001). A paucity of literature prevents further comparisons.

Write-in options in the public opinion self-administered mail questionnaire suggest the public is not generally aware of the county ban on discharging high-powered rifles. Many respondents expressed concerns about the safety of hunting on the island with rifles; many indicated the island simply was not big enough for hunting. This suggests that if the WDFW wants to increase the palatability of hunting on Whidbey Island for island residents, it would be beneficial to focus on the firearms restriction as a way of maintaining public safety. Additionally, focusing on the success and safety of suburban deer hunts in other regions may allay safety concerns (Kilpatrick and LaBonte 2003, Weckel and Rockwell 2013, Williams et al. 2013).

This study's substantiation of our prediction of support for increased hunting on Whidbey Island further supports Dietsch et al.'s (2011) assessment of wildlife value orientations in Island County; the high observed rate of utilitarians translated to willingness to support hunting. As stated above, the predominant reservation about increasing hunting on Whidbey Island was concern for public safety. Safety concerns in deer hunting have been expressed by others (Duda and Jones 2009). Human health, disease, and other factors have also been expressed as reservations for hunting (Decker and Gavin 1987, Decker et al. 2012).

The public and hunter surveys do not appear to correspond with the deer density gradient observed across the 3 sections of Whidbey Island (Wingard et al. 2019). While there was some evidence of less acceptability of the deer population in the central portion of the island, where the observed deer density was 10.5 deer/km^2, the acceptability of deer population was similar between regions. This suggests public opinion is, at most, weakly influenced by actual deer population densities. Researchers in Illinois, USA observed similar results where the observed deer density did not influence deer acceptance capacity of survey participants

(Urbanek et al. 2013). Krausman et al. (2014), however, reported that social carrying capacity was a strong influence for deer management in the West. Future research could concentrate on other relationships between the public and deer hunting (e.g., habitat features and hunter behavior [Lebel et al. 2012], disease and personal health risks [Needham et al. 2017], substitutes for hunting [Needham and Vaske 2013], other).

Many housing developments on Whidbey Island that are outside of city limits are regulated by a homeowner's association. Most of these prohibit hunting within the housing development and were a common reason respondents did not allow hunting on the property. The structure of homeowners' associations, however, makes them a good option for assessing management options for highly localized overabundant deer. If a housing development governed by a homeowners' association is experiencing locally overabundant deer populations, it can serve as a forum for exploring management options with the wildlife management agency.

Many respondents reported they changed their activities in response to interactions with deer. Common examples of this include installing fencing around gardens and reducing driving speed to minimize negative deer interactions.

A few respondents suggested contraceptive techniques or trap-relocate methods to control the deer population on Whidbey Island. The WDFW could explain these options clearly, and explain in depth the finding of various studies on these techniques, specifically, the ineffectiveness and high cost of contraceptive techniques at effective scales, and the high mortality rate of trap-relocate techniques (O'Bryan and McCullough 1985, McCullough et al. 1997, Kilpatrick et al. 2007). Other respondents expressed concern for the genetic health of the Whidbey Island deer population and suggested translocation as a means to incorporate new genetic material into the deer population. This should be of limited concern, as the population is large. Additionally, research from nearby Blakely Island has observed 3 round-trip, inter-island movements of 1 km each direction through the use of global positioning collars, suggesting inter-island movements may be more common than believed and the islands may not be geographically isolated (E. Long, Seattle Pacific University, personal communication).

Management implications

Our results suggested limited support for increasing deer hunting on Whidbey Island. If the WDFW wanted to increase support for deer hunting on Whidbey Island, they could focus on the restricted method of take for the island, as many respondents seemed unaware of the firearm restriction and are concerned for public safety. Given the lack of public land open to hunting on the island, however, little will be accomplished in terms of deer population reduction without increases in hunting access on private lands. The WDFW could focus their efforts toward expanding the Washington State Private Lands Access Program (https://privatelands.wdfw.wa.gov/private_lands/) on Whidbey Island (i.e., to increase hunting opportunities on private lands). In dealing with opposition to increasing hunting opportunity on Whidbey Island, the WDFW could use this research and conduct further human dimensions research to better understand diverse opinions.

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