NIH RELAIS Document Delivery

NIH-10114491

NIH -- W1 CA665S

ANDREW SILVERSTONE
MSC 1907
NCI, Building 10, 12C116
Bethesda, MD 20892

ATTN:		SUBMITTED:	2002-01-18 12:00:02
PHONE:	301-435 8061	PRINTED:	2002-01-23 16:15:13
FAX:	-	REQUEST NO.:	NIH-10114491
E-MAIL:		SENT VIA:	LOAN DOC
			5593728

NIH Fiche to Paper Journal

TITLE:	CANADIAN VETERINARY JOURNAL. LA REVUE VETERINAIRE CANADIENNE
PUBLISHER/PLACE:	Canadian Veterinary Medical Association Ottawa
VOLUME/ISSUE/PAGES:	2001 Aug;42(8):638-41 638-41
DATE:	2001
AUTHOR OF ARTICLE:	Silverstone AM
TITLE OF ARTICLE:	The state of the ecosystem on Anticosti Island, Qu
ISSN:	0008-5286
OTHER NOS/LETTERS:	Library reports holding volume or year 0004653 11519275
SOURCE:	PubMed
CALL NUMBER:	W1 CA665S
REQUESTER INFO:	ANDREWSDVM
DELIVERY:	E-mail: silversa@mail.nih.gov
REPLY:	Mail:

The state of the ecosystem on Anticosti Island, Québec

Andrew M. Silverstone

Abstract — The state of the ecosystem of Anticosti Island, Québec, was studied by veterinary students ($n = 17$) and faculty ($n = 4$) in the summer of 1999. The field of ecosystem health is an integrative science requiring the expertise of professionals in several disciplines, including socioeconomic, ecological, biophysical, human health, and animal health (1).

Résumé — L'état de l'écosystème de l'Île d'Anticosti au Québec. L'état de l'écosystème de l'Île d'Anticosti au Québec a été étudié par des étudiants vétérinaires ($n = 17$) et des professeurs ($n = 4$) à l'été 1999. Le champ de la santé des écosystèmes est une science intégrative nécessitant l'expertise de professionnels de plusieurs disciplines, dont la socioéconomie, l'écologie, la biophysique, la santé humaine et la santé animale.

(Traduit par Docteur André Blouin)

Can Vet J 2001;42:638–641

Introduction

Anticosti is a 7923.2-km^2 island located in the Gulf of St. Lawrence in the province of Québec (62°45′W; 49°25′N). In 1896, several exotic species of wildlife were introduced to the island. Included were 220 white-tailed deer, obtained from the Québec mainland, which served as the foundation for the present population (2). Since 1975, trophy hunters have come from around the world, killing a reported 8000 deer in a controlled hunt each autumn. At the time of the study, 395 people lived on the island (3), along with an estimated spring population size of 80 000 to 100 000 white-tailed deer (*Odocoileus virginianus*), which peaked at 120 000 in the fall. This population of white-tailed deer represents the species' northernmost range extension in northeastern North America (2). No natural predators of the deer exist on the island, but Anticosti has long winters with deep snowfall (4). Because of these circumstances, Anticosti Island provided a challenging case study in ecosystem health.

The hypothesis of this study was that the deer population was exceeding the carrying capacity of the island. This was hypothesized due, in part, to a lack of natural predators of the white-tailed deer on the island. Methods of this investigation included informal subjective interviews with people living on the island, discussions with field biologists and stakeholders in Anticosti's future, field assessment of the ecosystem, literature review of previous studies relating to the island, and necropsy of deer carcasses ($n = 5$). Socioeconomic factors affecting the island's people were also considered; however, the focus of the investigation was limited to the expertise and viewpoint of a veterinarian.

Ecosystem health is a multidimensional evaluation of an ecosystem's capability for maintaining its structural status quo, growing and producing, and responding to stresses imposed by nature and humankind. An ecosystem has been defined as the water, soil, air, and organisms (including people) interacting within a geographic area. The objective of this field-based rotation was to provide clinical experience in ecosystem health by studying the interactions among the epidemiological "triad" of the environment, agents, and hosts (5). The needs and health of the people and deer on Anticosti and the diversity of the forest were considered in making this evaluation, as an interconnection exists among all 3 components of this ecosystem.

Materials and methods

The health of the ecosystem of Anticosti Island, Québec, was examined in the summer of 1999 by students ($n = 17$) and faculty ($n = 4$) from each of the 4 Canadian veterinary colleges (Atlantic Veterinary College, Faculté de médecine vétérinaire, Ontario Veterinary College, and Western College of Veterinary Medicine), as part of a 4th year rotation.

Methods used to evaluate the ecosystem health included informal subjective interviews with people living on the island, discussions with field biologists and stakeholders in Anticosti's future, field assessment of the ecosystem, literature review of previous studies relating to the island,

Atlantic Veterinary College, 550 University Avenue, Charlottetown, Prince Edward Island C1A 4P3.

Dr. Silverstone's current address is National Cancer Institute, Department of Experimental Transplantation and Immunology, National Institutes of Health, Bldg. 10, Rm 12N226, MSC 1907, Bethesda, Maryland 20892 USA.

Andrew Silverstone will receive a copy of *Saunders Comprehensive Veterinary Dictionary* courtesy of Harcourt-Brace Canada.

Funding for the Ecosystem Health rotation was provided by the Max Bell Foundation.

and necropsy of deer carcasses. Groups of 2 or 3 students conducted the interviews by canvassing the town of Port Menier, the island's population center. The student groups included at least one French-speaking student. The townspeople were approached at public places and asked to give their opinions and observations about the abundance of deer on Anticosti Island. Meetings were arranged by appointment with stewards of the island's natural resources. In studying this ecosystem, the veterinarian's role included working with wildlife and population medicine, environmental toxicology, and epidemiology.

Results

Subjective interviews and discussions with field biologists and stakeholders

The number of deer on the island was considered to be quite high, and their proliferation was reported to have created a nuisance to many of the townspeople. Numerous deer were observed by the researchers walking freely within the town, and were reported to consume plants from vegetable and flower gardens that were not fenced off. It was mentioned by the hunting guides during the informal interviews that, during winter, the deer consumed an atypical diet that included seaweed.

Individuals who had worked as hunting guides for many years were of the opinion that the average body size of the deer had been decreasing yearly. Based on the discussions, it was this author's belief that the number of deer killed per year was much higher than the number officially reported. Reportedly, hunters were killing several deer during a day and only "claiming" the 1 or 2 bucks with a head most suitable for mounting as a trophy. Officially, a deer license permitted one individual to kill up to 2 deer (male or female) during the specified season.

Field assessment

The forest was predominantly spruce trees (*Picea* spp.), which were not palatable to the deer. There was a paucity of ground vegetation on the forest floor. The boreal forest provided good shelter; however, the extensive browsing by the overpopulation of deer had decreased the diversity of plant life in the forest, as few hardwoods, deciduous bush, and ground cover were observed to be growing in the forest. Stands of mature birch, poplars, and firs were present, but with few branches or leaves at deer height. Only in experimental areas fenced off from the deer were hardwoods and other vegetation observed to be flourishing.

Necropsy results

Five deer carcasses were necropsied. A local biologist provided 3 carcasses that were found near Port Menier. The other 2 carcasses were found by the group along the Vaureal River valley (5 deer carcasses were observed along a 3.5-km stretch of the river, all of which had apparently fallen off of the cliffs). In 4 of the 5 carcasses examined, severe serous atrophy of fat, with translucent femoral bone marrow, was observed. In 2 of the 3 carcasses provided by the biologist, there was evidence of blunt trauma, consistent with a collision with an automobile. Ruminal findings included items of low nutritional value: fir (*Aibes* spp.) needles, spruce needles, and wood fiber. Processed corn and wheat were found in the rumen of 2 deer whose carcasses were found near the town.

Discussion

Animal health

The survival of young white-tailed deer is dependent on a constellation of factors, including the dam's nutritional status, parasite load, disease, social stresses, and the population density (6). On Anticosti, these factors exist in a delicate balance, which may easily be susceptible to collapse. Environmental changes affecting the food supply could prove to be dramatic. During a typical winter, the snow persists for 5 to 6 mo, limiting the variety and abundance of food sources. In wintertime, the deer consume lichens from fallen trees (4). In order to survive the winter, the deer on Anticosti minimize their expenditures of energy. Adults rely on 20% to 25% of their fat reserves, while fawns will consume one third of their body reserves to supply their energy needs (Huot J, personal communication).

Nutritional factors

Deer in eastern Canada reportedly prefer to consume white cedar and various hardwoods during winter (8). In one study of deer on Anticosti, analysis of ruminal contents indicated that *Picea* spp. and *Abies balsamea* accounted for 98.5% of the browse consumed from February to April. The dry weight of the ruminal contents included 9.5% lichens. Forbs compose the majority of the deer's diet during the snow-free months (Huot J, personal communication). A normal diet for wild deer consists of coniferous and deciduous leaves, buds, and twigs (7). One source of the corn and wheat observed in the necropsied deer was the supplemental feeding frequently observed in the town of Port Menier and reportedly used by some hunters to attract deer into clearings. A previous report implicated supplemental feeding as a culprit in the overpopulation of white-tailed deer (8); however, in this situation, the feeding of the deer did not significantly influence the population size on the island. The necropsied carcasses whose rumen contained processed feed were found near the town, and the survival of deer living deeper in the forest is unlikely to be affected by consuming processed grains.

Parasite burden

Small-scale farming was present on the island, making the introduction of disease and parasites to and from domestic ungulates a concern. Other studies have described the interrelationship of parasites in wild deer and livestock (8,9). Pathogenic parasites transmissible to white-tailed deer from sheep include *Haemonchus contortus* and a *Strongyloides* sp. (6). It was noteworthy that Anticosti is only 1 of 2 locations in North America where the European species of *Ostertagia spiculoptera* is known to exist; however, it was not detected in the necropsied specimens.

Viruses and subclinical disease

Two previous studies were performed in 1985 to assess serologic evidence for the presence of bovine

herpesvirus 1 (BHV-1), bovine viral diarrhea virus (BVDV), and parainfluenza 3 (PI-3) virus in deer on Anticosti. At the time of these studies, small-scale farming had not been present on the island and the last known contact with domestic ruminants would have to have occurred over 50 y previously. A high prevalence of antibodies to BHV-1 and PI-3 virus was detected, with no serological evidence of infection with BVDV. The detection of antibodies to BHV-1 and PI-3 virus demonstrated that the deer had been exposed to viruses antigenically similar to the strains of these viruses that affect livestock. The BHV-1-related virus was considered an epizootic strain of low virulence that contributed to subclinical disease with low morbidity and mortality. This strain of BHV-1-related virus was speculated to be one culprit in an unusual die-off of the Anticosti deer in 1985. Researchers determined that the prevalence of antibodies to BHV-1 in the Anticosti deer decreased over a 3-year period, yet remained the highest to be observed in a population of wild ungulates. The prevalence of antibodies to PI-3 virus was also higher than that observed in other North American deer populations, but remained stable over the 3-year study. This PI-3 virus infection was felt to represent an enzootic infection of the Anticosti deer. The researchers concluded that the stressful conditions of Anticosti's environment contributed to a state of immune suppression in the deer, which persistently shed BHV-1 and PI-3 virus-related viruses (3,10).

Population density and social stress

The dynamics for a population of this size are unusual. In other studies of the population of white-tailed deer, the maximal density of 12 deer/km^2 represented a healthy peak population size (7), with an expected decline to 9 to 10 deer/km^2 after a typical winter (8). When the population of deer on Anticosti was at its peak of 120 000 in the fall, there was a density of 15 deer/km^2. This high density was due, in part, to the lack of natural predators. The population density at the springtime nadir was 10 to 12 deer/km^2, varying with the severity of the winter. The most significant factor in the mortality of the deer was deemed the winter weather (11).

Because of the large population size, a larger proportion than normal of this population was susceptible to starvation in winter. Anticosti has a very long winter, lasting an average of 156 d, and a deep snowfall. The limited food supply during winter was the significant bottleneck limiting the size of the deer population. Snow cover in February and March prevented access to ground vegetation, leaving *Picea* spp. and *Abies balsamea* to account for 95% of the available biomass. The fat reserves of the deer dropped significantly from a peak in the fall to a nadir in the spring. Fawns had fat reserves of 15.3% in the fall, which dropped as low as 0.2% in the spring, representing a 41% loss in body weight. Body weight losses in the winter ranged from 31.7% to 58.9% in fat and 17.8% to 23.0% in protein. Based on the decline in the body condition of the deer, the conclusion is that the deer base their strategy for survival during the winter primarily on energy conservation and secondarily on food consumption (Huot J, personal communication). In comparison, deer from the mainland generally weigh 20% more and have a higher reproductive rate than do deer on Anticosti Island (4,12).

Socioeconomic health

Economically, the health of the island's people was marginal, dependent on the money brought in by visiting deer hunters. A collapse in the deer population would likely be devastating to the economy and livelihood of the people. The economy was virtually a monoculture, entrenched in the seasonal earnings provided by the visiting hunters and logging, thus interdependent on the survival of the forest. The most recent census recorded that the island's unemployment rate was 53%, significantly higher than the Canadian nationwide unemployment rate of 10% (13). There was no high school on the island, so residents who wished to obtain a high school education moved off the island to complete their schooling. An extrapolation could be made that the absence of a high school on the island contributed to the high rate of unemployment.

If a collapse in the deer population were to occur, there may be a resultant increase in the exploitation of the island's forests for wood and paper products and pressure to increase fossil fuel exploration (14,15). Without an alternative source of income, the island's economy would likely fail. Possible strategies to prevent such an ecological and economical collapse may include diversifying the economy to include less invasive ecotourism, increased hunting to allow sectors of the forest to grow, culling some deer, or fencing off large areas of forest from deer to allow the vegetation to regenerate. An effective strategy would require both short-term and long-term actions, as well as an extensive monitoring program (16). Improvements to the health of the forest that may be deleterious to the deer in the short term may lead to an increase in the available food sources in the long term.

The introduction of predators was discussed as an alternative measure for controlling the deer population; however, Anticosti is considered to be rabies-free and no dogs are permitted on the island. Such a move could have a serious impact on the red and silver fox population (*Vulpes fulva*); the latter was introduced for fur farming in the 1910s. If disease-free carnivores were introduced (possibly wolves, cougars, lynx, or bobcats), the displaced fox population might develop into a nuisance problem.

Conclusion

As a whole, Anticosti has a distressed ecosystem. The ecosystem's ability to adapt to further ecological or economical changes was deemed to be equivocal. The deer existed in such high numbers that the forest was unable to meet their nutritional needs throughout the year. This limitation was due, in part, to the deer being an introduced species. With no natural predators present, the deer population grew to a size that could not be sustained by the forest during the winter. Furthermore, the indigenous vegetation was generally of lower nutritional value than that of the preferred diet of mainland deer. The island's ecosystem was able to sustain the introduced species, but at the expense of the forest's diversity. The deer population appeared to be stable under the

current conditions; however, its status might be leading to its own demise. The deer's over-consumption of the forest vegetation had severely decreased the diversity of the flora. The lack of variety limited the options for alternate foods, should the deer's current sources fail.

The deer on Anticosti may be naive to many of the diseases and parasites that affect their mainland counterparts. Introduction of an exotic disease could pose a dramatic threat to the deer. Exposure to these agents may occur through incidental contact with new introductions of farm animals or new deer to the island. Lack of genetic diversity, in the face of a population crash, was also a consideration. As most of the deer are hunted for a trophy, an unnatural selection against the larger, and presumably genetically healthier, deer is occurring. This selective thinning of the genetic pool may prove to be of significance if the deer are faced with a challenge to their population's stability. Nevertheless, starvation in the winter provides the most significant source of selective pressure, as it was the main mortality factor.

Evaluating the ecosystem health of Anticosti Island was a challenging task, encompassing areas such as population epidemiology, project design, wildlife pathology, botany, and sociology. The limitations in sample size and methods underscore the logistical, economic, personnel, and time constraints that limited the completeness of this study of the ecosystem's health. This study exemplified the importance of a veterinarian's knowledge and understanding in evaluating and managing animal populations, and in comprehending how these dynamics relate to public and environmental health. With increasing awareness of environmental issues, veterinarians are one of the professional groups likely to be consulted on the matter of ecosystem health.

Acknowledgment

I thank Dr. Jeff Davidson for his mentoring of this article.

CVJ

References

1. VanLeeuwen JV, Nielsen NO, Waltner-Toews D. Ecosystem health: an essential field for veterinary medicine. J Am Vet Med Assoc 1998;212:53–57.
2. Newson WM. Mammals on Anticosti Island. J Mammal 1937; 18:435–442.
3. Statistics Canada. Profile of Census Divisions and Subdivisions. Ottawa: Industry Canada, 1999. 1996 Census of Canada. Catalogue number 95-186-XPB,1996:1979.
4. Lamontagne L, Sadi L, Joyal R. Serological evidence of bovine herpesvirus 1-related virus infection in the white-tailed deer population on Anticosti Island, Quebec. J Wildl Dis 1989;25:202–205.
5. Ribble C, Hunter B, Larivière N, et al. Ecosystem health as a clinical rotation for senior students in Canadian veterinary schools. Can Vet J 1997;38:485–490.
6. Sams MG, Lochmiller RL, Qualls CW, Leslie DM, Payton ME. Physiological correlates of neonatal mortality in an overpopulated herd of white-tailed deer. J Mammal 1996;77:179–190.
7. Banfield AWF. Mammals of Canada. Toronto: University of Toronto Pr, 1974:391–395.
8. Schmitt SM, Fitzgerald SD, Cooley TM, et al. Bovine tuberculosis in free-ranging white-tailed deer from Michigan. J Wildl Dis 1997;33:749–758.
9. Foreyt WJ, Tainer DO. Seasonal parasitism changes in two populations of white-tailed deer in Wisconsin. J Wildl Manag 1980;44:758–764.
10. Sadi L, Joyal R, St-Georges M, Lamontagne L. Serologic survey of white-tailed deer on Anticosti Island, Quebec for bovine herpesvirus 1, bovine viral diarrhea, and parainfluenza 3. J Wildl Dis 1991;27:569–577.
11. St.-Georges M. Reproduction et mortalité du cerf de virgine dans le sud-est de l'Ile d' Anticosti [MSc thesis]. Univeristé de Québec à Montréal, Montréal, Québec, 1989:84 pp.
12. Goudreault F. Reproduction et dynamique de la population de cerfs de l'Île d'Anticosti [MSc thesis]. Laval University, Québec, 1980:134 pp.
13. Wood J, ed. Canada Yearbook 1999. Ottawa: Statistics Canada, 1998:209.
14. Dixon RV. Pulpwood truck-train haul — Anticosti Island, 1968. Pulp Pap Mag Can, 1969;70(22):97–101.
15. Sanford BV. Geology and oil and gas possibilities of the Gulf of St. Lawrence Region, southeastern Canada. Ottawa: Natural Resources Canada, Geological Survey of Canada, 1997:63 p.
16. Wobeser GA. Investigation and Management of Disease in Wild Animals. New York: Plenum Press, 1994.