WILDLIFE RESEARCH NEEDS FOR ALBERTA

A report to the Alberta Conservation Association

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Soon after my arrival in Alberta in 1999 to assume the Alberta Conservation Association Chair in Fisheries and Wildlife at the University of Alberta I organized meetings with ACA and Fish and Wildlife staff to identify research needs in fisheries and wildlife in Alberta. My intent was to identify research needs that would most benefit fisheries and wildlife management programs in Alberta. And by circulating this list amongst Alberta researchers we hoped to encourage research to meet the needs of field biologists who must make management decisions.

My intent with this report is to update the list of research needs for wildlife. Following is a list of the wildlife projects that were identified in 1999-2000 along with notes about the status of the research. The original report on fish and wildlife research priorities has a more complete description of each project idea. Projects are listed here in the order that they were ranked by the SMART process (Ralls and Starfield 1995) based on a survey of Alberta field biologists on priority criteria. A high proportion of the research projects identified 5 years ago are now underway, completed, or covered in some way or another. I believe that bringing these research needs to the attention of researchers in government, universities, ACA, and other NGOs has helped to ensure that these needs are being met.

Following this list are two new lists of research needs identified by wildlife staff working for Fish and Wildlife (Alberta Sustainable Resource Development), ACA's Wildlife Team, Canadian Wildlife Service, and Ducks Unlimited. My primary objective is to identify research needs that are not currently underway as a guide for researchers, but during the process of identifying new research needs, I was made aware of a number of new projects underway that were identified as priority work. For completeness I have listed these as well separately. Additional information about ongoing wildlife research in Alberta can be found on the websites of the Alberta Cooperative Conservation Research Unit (ACCRU), and the ACA.

This is not intended to be a complete inventory of wildlife research needs, but rather those identified as priority projects by field biologists working in Alberta. This does not in any way imply that other research is not needed or might be of crucial importance for management. Nevertheless, we hope that this list will help

to stimulate research efforts that will meet identified resource management needs in Alberta.

Thanks to the many government and ACA field staff who met with me to review research needs. Special thanks to Jim Allen, Eldon Bruns, Bob Clark, Rob Corrigan, Bill Gummer, Velma Hudson, Paul Jones, Evie Merrill, Jim Skrenek, Kirby Smith, and Jonathan Thompson.

PROJECTS FROM THE 1999-2000 REVIEW OF RESEARCH PRIORITIES

Topics on which research has been initiated are followed by a check mark (√). Those topics that remain as research needs but for which I am unaware of any research effort are highlighted in yellow.

1. ►Crowsnest/K-Country wildlife corridors √

A project on corridor and reserve design relative to cougars (*Felis concolor*) and grizzly bears (*Ursus arctos*) was undertaken by Cheryl Chetkiewicz, Ph.D. student at University of Alberta. Y2Y initiatives by the Wilburforce Foundation have supported this work along with contributions from ACA, SRD, the Wildlife Conservation Society, Shell Canada, and Wildlife Habitat Canada. Cheryl has approximately one year of fieldwork remaining; this project is supervised by the ACA Chair.

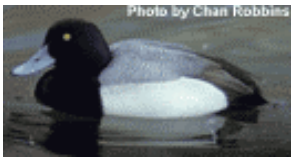
In addition to Cheryl's work, several related projects have been completed recently related to movement corridors and habitat connectedness for various species of wildlife in the Rocky Mountains of western Alberta (Clevenger and Waltho 2001; Clevenger et al. 2001a, 2001b, 2002, 2003, Little et al. 2002). This includes projects on small mammals (McDonald 2002, McDonald & St. Clair 2004a, 2004b), birds (Bélisle & St. Clair 2001, St. Clair 2002, Hannon & Schmiegelow 2004, Muir 2004), cougars (Riley & Malecki 2001), wolves (*Canis lupus*; Whittington et al. 2004), and bears (Alexander & Waters 2000). No lynx (*Lynx canadensis*) or fisher (*Martes pennanti*) work is being done to my knowledge although studies involving these species are underway in adjacent areas of British Columbia. Research on lynx and fisher in Alberta may be warranted.

2. ►Greater sage-grouse (*Centrocercus urophasianus*) winter ecology √

This work is an ongoing multi-agency study involving Cameron Aldridge, Ph.D. student at the University of Alberta, Paul Jones with ACA, and Joel Nicholson with SRD. We continue to work toward initiating grazing manipulation experiments to understand the role of grazing in the habitat ecology of this species (Aldridge et al. 2004). Funding has come from the Habitat Stewardship

Program (CWS), Endangered Species Recovery Program (WWF), SRD, and ACA. Cam Aldridge's thesis is supervised by the ACA Chair.

3. ►Declines of lesser scaup (*Athya affinis*) √



We do not understand reasons for widespread population declines in lesser scaup, a duck that nests in Alberta, particularly in central and northern parts of the province. Among factors being considered as contributing to the decline are nutrient reserves of females and the effect of contaminants on the survival of adults. Ring-necked ducks (*Aythya collaris*) are close relatives of scaup, and both species share breeding and wintering ranges. Curiously, populations of ring-necked ducks have been stable or increased during the decline in scaup numbers, suggesting that factors that negatively influence scaup do not effect ring-necks. Graduate student Jean-Michel Devink (University of Saskatchewan) has been collecting both lesser scaup and ring-necked ducks upon their arrival at their boreal forest breeding sites and again later during incubation. By comparing lesser scaup with ring-necks, Jean-Michel hopes to identify what factors have contributed to the decline of scaup. This research is supervised by Bob Clark, CWS. See website: http://www.deltawaterfowl.org/research/students.html

Although this research is underway, this project is not sufficiently comprehensive and additional study is believed necessary.

4. ►Reasons for decline of pintails (*Anas acuta*) √

Land-use changes, especially associated with reduced availability of secure nesting sites in fallow fields, have been identified as contributing to declines in northern pintails. Terry Kowalchuk is working on this project for his Ph.D. under the supervision of Bob Clark, CWS. A extensive bibliography on northern pintails can be found at: http://www.npwrc.usgs.gov/resource/literatr/pintbibl/pintbibl.htm

5. ►Beaver (*Castor canadensis*) landscape ecology √

Two graduate-student projects on landscape ecology of beavers in boreal forests of northeastern Alberta are being supervised by Lee Foote at the University of Alberta. Kathryn Martell (2004) recently has completed her thesis, with the ACA Chair serving on the supervisory committee. Another beaver project at a broader spatial scale is underway by Nadele Flynn under Lee Foote's supervision. Beaver effects on biodiversity is a complex issue that needs further work in other parts of the province.

6. ►Resource selection functions for grizzly bears for Cumulative Effects Assessment. √

This is part of Scott Nielsen's Ph.D. thesis with expected completion in October 2004, supervised by the ACA Chair. Relevant recent publications include Nielsen et al. (2002, 2003, 2004a, 2004b, 2004c).

7. ►Watershed experiment--IRM program √

Al Sanderson with Alberta Environment heads a team of government staff and consultants developing Integrated Resource Management plans for various parts of Alberta. The northern East Slopes of Alberta were one of the first areas to be considered by the IRM team. The ACA Chair's graduate student, Scott Nielsen, has been instrumental in developing models to predict the consequences of cumulative effects on grizzly bears for the NE slopes. Given current political priorities for the Alberta Advantage, an experimental program has not proved feasible. A more recent initiative for southern Alberta has engaged assistance from another ACA Chair student, Cam Aldridge, for work on habitat models of greater sage-grouse.

8. ►Riparian management & buffers √

Riparian management has received considerable attention from the Cows and Fish program sponsored by ACA and SRD (www.cowsandfish.org). In addition, evaluation of buffers in context of beaver management was one of the topics addressed in Kathryn Martell's (2004) M.Sc. thesis at the U of A under the direction of Lee Foote; the ACA Chair served on the supervisory committee for this thesis. Other work on the ecology of buffers for amphibians, small mammals and songbirds in Alberta has appeared in print recently (Hannon et al. 2002, McDonald et al. 2004), and Lee and Boutin (2004) have compiled a broad review of riparian buffer management in North America.

9. ►Grazing management for sharp-tailed grouse √

This work is part of a continuing effort by Paul Jones to monitor the success of ACA's Native Prairie Stewardship program with partnered contributions from ACA and the CWS Habitat Stewardship Program. In addition, Doug Manzer (2004) defended his Ph.D. dissertation at the U of A on this topic supervised by Dr. Susan Hannon. The ACA Chair served on Manzer's supervisory committee.

10. ►Waterfowl nest predators. √

Nest predators have been shown in Manitoba, South Dakota, and North Dakota to influence waterfowl nesting success, and predator-control programs to reduce red fox (*Vulpes vulpes*), coyotes (*Canis*

latrans), skunk (*Mephitis mephitis*), and raccoon (*Procyon lotor*) densities can be effective at enhancing waterfowl production (www.deltawaterfowl.org). Barbara Maile (MSc. 2003) worked with Lee Foote and IWWR researcher Jim Devries to examine nest predation and opportunities for providing alternate prey (small mammals and insects) through habitat management techniques of haying an burning in tame and native pastures. Her work was conducted on 45 managed cover Ducks Unlimited projects in Eastern Saskatchewan and Manitoba.

Barbara Maile with hen Mallard from nest in alternate prey study.

Evaluation of such programs in Alberta may be worthwhile albeit controversial because of public aversion to predator control. A non-invasive study to identify habitats where nest predation is lowest could be done using radiotelemetry to construct RSF models for predators in key waterfowl nesting areas, e.g., near Buffalo Lake in central Alberta. This remains as a priority wildlife research need in Alberta. Rob Stavne, recently (2004) completed his M.Sc. working with Lee Foote examining waterfowl nest predation in the pond riparian zone of 120 ponds in the Buffalo Lake region which has the highest waterfowl nesting density in the province.

11. ►Linear disturbances on prairies √

Several projects involve analysis of wildlife consequences of linear features on Alberta's prairies. Alberta Environment's IRM program for the SASS initiative includes extrapolating the consequences of linear feature developments on wildlife in the area, including sage-grouse. Cam Aldridge, Ph.D. student under the supervision of ACA Chair, has developed models the greater sage-grouse as part of this initiative. In addition, pronghorn work supervised by Cormack Gates at the U of C is evaluating the effects of roads and other linear features on pronghorn. Perhaps the most comprehensive program is the "MULTISAR" Milk River Basin Habitat Stewardship program that involves developing Habitat Suitability Index (HSI) models for a list of species of management interest in the

Milk River basin (Downey et al. 2004). These projects are funded by the ACA, SRD, and the Habitat Stewardship Program of the CWS. Because of the complexity of wildlife needs in this region, this remains a priority for additional research.

12. ►Botulism management for waterfowl √

A broad-scale study across Prairie provinces evaluated the effectiveness of carcass cleanup and was unable to show improved survival when cleanup has been done (http://www.pnr-rpn.ec.gc.ca/info/news/cc00s95.en.html). Generally the message emerging from this NAWMP-funded research is that there is no use collecting carcasses that result from Botulism poisoning, and more effective is watershed management to avoid creating conditions that lead to botulism in the first place. This research was conducted by the Canadian Cooperative Wildlife Health Centre in Saskatoon with Margo Pybus (SRD) as the Alberta representative.

13. ►Ground squirrels as keystone spp. √

Dr. Gail Michener at the University of Lethbridge has been conducting demographic studies on the Richardson's ground squirrel for several years (http://people.uleth.ca/~michener). This research effort focuses on details of life history and demography but also includes broader ecosystem significance of the species (www.albertapcf.ab.ca/PDF_Documents/Richardsons.pdf). A survey protocol for monitoring Richardson's ground squirrels has been developed (Downey 2003) with support from ACA.

14. ►Cottonwoods (*Populus* spp.) and flushing flows. √

Cottonwood forests provide important habitats for a diversity of species of wildlife in prairie and foothill ecoregions. Declines in riparian cottonwoods along rivers in southern Alberta has been the research program for S. Rood at the University of Lethbridge (Samuelson and Rood 2004). In addition, complementary work has been done in adjacent areas of Montana (Pearce and Smith 2001).

15. ►Ecosystem management on prairies. √

References regarding this project are included in the prairie linear features discussion above (topic rank #11). Nicky Koper has recently completed her PhD under Dr. Fiona Schmiegelow. She studied the success of ground nesting passerines, shorebirds and waterfowl in relation to predation rates and habitat fragmentation in the Brooks area.

16. ►Evaluate habitat improvement for elk on the east slopes √

This effort is part of the ongoing Central East Slopes Elk Study (CESES), and Jacqui Frair is a Ph.D. student working on this study under the supervision of E. H. Merrill at the University of Alberta (http://ursus.biology.ualberta.ca/elk). The ACA Chair is a co-PI on this study that receives continuing support from ACA, Sunpine, Rocky Mountain Elk Foundation, Weyerhaeuser, and the National Science Foundation (USA). ACA recently contracted with a consultant for a review of its ungulate habitat management programs.

17. ►Access management experiments √

Experimental designs for the East Slopes of Alberta have not been developed, although retrospective studies on the current distribution of various wildlife species is being evaluated in context of access management. Carrie Roever (M.Sc. thesis project) is part of the FMF team studying habitat selection and movements by grizzly bears, under the supervision of the ACA Chair. In addition, evaluating the consequences of access management to elk distribution and movements is part of Jacqui Frair's Ph.D. work on elk under the supervision of E. Merrill. Another experimental study designed to evaluate the effectiveness of access management for black bears is Sophie Czterwertynski's study in NE Alberta (http://ursus.biology.ualberta.ca/blackbears/). Additional experimental studies of road closures and other forms of access management should be conducted to rigorously document the consequences of industrial development.

18. ►Land-use effects on small mammals √

Small mammal distribution and abundance is being studied in NE Alberta where there is continuing research effort to examine the effects of industrial development on the Alberta Pacific Forest Management Area. Small mammal responses to timber harvest are described by Moses & Boutin (2001).

19. ►Unmixing the mixedwood forests, spraying effects √

The ecology of several species of wildlife are being impacted by Alberta's forest management policy that encourages silivicultural practices such as use of herbicides that "unmix" mixedwood forests by creating separate conifer and hardwood stands (Hobson & Bayne 2000). A rich biota has been identified in aspen mixedwood forests including 47 lichen species, 39 mosses, 7 liverworts, 24 fungi, 11 pteridiophytes (horsetails, club mosses, and ferns), 65 herbs, 27 shrubs, 6 trees, 3 amphibians, 76 birds, and 33 mammals (Stelfox 1995). ‘‘The Bay-breasted Warbler (*Dendroica castanea*) is currently included on the 'Blue List' of species that may be at risk in Alberta, due to concerns over habitat loss and declines in populations in some areas. Bay-breasted Warblers are neotropical migrants that breed in the Boreal Forest and Foothills Natural Regions of Alberta. They require mature to old forest stands with a predominantly

coniferous (usually spruce) canopy. Mixedwood stands of white spruce and trembling aspen or balsam poplar are typical of this species' habitat in Alberta. The principal concern over the status of the Bay-breasted Warbler relates to loss and degradation of its breeding habitat caused predominantly by the activities of the forestry and energy sectors. Silvicultural practices and government policy currently promote harvesting of older stands, and an "unmixing" of mixed-wood stands. Exploration and development for oil and gas further contributes to habitat loss and dissects large areas of forest with extensive linear disturbances" (Norton 2001). Similar quotes can be extracted from the Alberta status reports on the brown creeper (*Certhia americana*; Hannah 2003) and the black-throated green warbler (*Dendroica virens;* Norton 1999). A review of the ecological effects of herbicide application in northern forests is provided by Lautenschlager and Sullivan (2002).

Ecological consequences of unmixing the mixed woods are considerations in the BEEST study overseen by Fiona Schmiegelow, U of A Department of Renewable Resources and selected projects being conducted in the EMEND program, overseen by Dr. John Spence. Funding comes from a long list of sponsors including the Sustainable Forest Management Network, which is part of the federal National Centres of Excellence, NCE program. An ACA-funded study is one by Wayne Strong at the University of Calgary evaluating the long-term (16-year) effects of hexazinone application on regenerating aspen. The full consequences of broad-scale herbicide application have not been documented.

20. ►Elk relocation studies √

This effort is part of the ongoing Central East Slopes Elk Study, and part of Jacqui Frair's Ph.D. dissertation. The ACA Chair is a co-PI on this study that receives continuing support from ACA, Sunpine, Rocky Mountain Elk Foundation, Weyerheauser, and the National Science Foundation (USA). An excellent summary of progress on the project can be found at the CESES website:
http://ursus.biology.ualberta.ca/elk/translocation.htm
Also, a recent publication by Frair et al. (2004) details some of the radiotelemetry methods developed for the study.

21. ►Fisher habitat models √

Based on fur harvest returns, fisher abundance was low during the late 1980s but increased during the 1990s (Poole & Mowat 2001). Analysis of industrial development consequences on fisher habitats in NE Alberta is part of the AME retrospective research by Erin Bayne, Rich Moses, and Stan Boutin at the University of Alberta (http://www.ameteam.ca/). Monitoring was done using an adaptation of the Finnish snowtrack triangles (Lindén et al. 1996) and a compilation of recent fur harvest records. Road construction associated with

industrial development has a strong negative influence on fisher. Support has been provided by the SFM NCE and Alberta Pacific. ACA also is supporting the initiative entitled "Cumulative Impacts and Management of Industrial and Agricultural Development on Selected Furbearer and Game Species in Alberta's Northeast Boreal and Boreal-Parkland Transition Zones."

22. ►RSF of elk for CEA/test HSI model √

An elk winter foraging habitat suitability index (HSI) model was developed in 1999 (http://www.fmf.ca/HS/HS_report28.pdf). Subsequently, models of winter habitat selection at multiple spatial scales were developed by Jones and Hudson (2002), and an evaluation of the HSI model for elk winter ranges in west-central Alberta was completed (Jones et al. 2002). Resource selection functions (RSF) can be used to estimate HSI models with greater statistical rigour (Manly et al. 2002), and the explicit incorporation of landscape variables using RSF enhances model performance (Dettki et al. 2003). Jacqui Frair has estimated RSF models and will be developing cumulative effects assessment algorithms for elk on the central east slopes as part of her Ph.D. thesis in the Department of Biological Sciences at the University of Alberta. The CESES project is supervised by E. H. Merrill with the ACA Chair serving as a co-principal investigator (http://ursus.biology.ualberta.ca/elk/).

23. ►Resource selection functions of moose (*Alces alces*) with applications for cumulative effects assessment √

In 1999 the Foothills Model Forest developed a habitat-suitability index for winter moose habitats in Alberta (http://www.fmf.ca/HS/HS_report27.pdf). Jason Kerr studied moose habitat selection in the FMF. Then more recently, Osko (2003) completed his Ph.D. developing use versus availability RSF models for moose in the AlPac FMA in NE Alberta. Since then Kerri Charest has studied aerial survey data on moose in the AlPac FMA relating abundance to a variety of landscape metrics under the supervision of Stan Boutin. A description of Kerri's project can be found at the ILM website: (http://www.biology.ualberta.ca/faculty/stan_boutin/ilm/index.php?Page=2347).

24. ►Wildlife habitats on private lands survey

We do not have a good understanding of wildlife resources on private lands in Alberta, although there are continuing efforts such as ACA's Native Prairie Stewardship Program and the Cows and Fish program that work closely with landowners to advocate habitat management for wildlife. Lee Foote, in the Department of Renewable Resources at the University of Alberta, is conducting a survey related to opportunities to develop economic incentives for landowners to manage for wildlife resources on their lands, but this not a comprehensive survey. Another initiative is underway by the Hunting for Tomorrow Foundation

to catalogue areas within the “white zone” of Alberta where public access for hunting and fishing is permitted.

25. ►Status of the white-winged scoter (*Melanitta fusca*) in Alberta

Monitoring work is ongoing by the CWS, but a focused research effort on this species may be warranted to evaluate reasons for the precipitous decline of the species in Alberta. Krementz et al. (1997) noted that the ratio of young per adult in the harvest has declined and some of this appears to be related to reduced recruitment, as well as hunter harvest. A status review on this species provides a review of known status and management issues (Kehoe 2002).

26. ►Ecology of long-tailed weasel (*Mustela frenata*)

Recent work on this species in Indiana indicates sensitivity to habitat fragmentation (Gehring and Swihart 2004), but we have little information on habitat requirements in Alberta. Agricultural intensification appears to have resulted in substantial declines in abundance. Earlier work on distribution throughout Alberta by Proulx & Drescher (1993) was based on a postal survey.

27. ►Density dependence in moose populations

Optimal harvest policies for ungulate populations require information on density dependence in vital rates of survival and reproduction. Although harvesting models for moose have been developed in Scandinavia (Saether et al. 2001) comparable work in systems with wolf predation needs additional attention. Albeit controversial (Eberhardt 2000) evidence exists that wolf (*Canis lupus*) predation on moose is density dependent (Messier and Joly 2000), and hunter harvest regulations often reinforce density-dependent mortality. Density of moose in Canada negatively influences growth, reproductive rates, and calf recruitment (Ferguson et al. 2000). Increasing amounts of open habitats associated with industrial development are likely to require more careful attention to harvest management (Ferguson et al. 2000). Recent efforts to reduce moose populations using liberal harvest quotas in areas occupied by woodland caribou (*Rangifer tarandus*) present opportunities to document density-dependent responses by moose in Alberta. Such data would be useful to validate harvest models (see item ranked #34 below). May want to include Terry Osko’s PhD here.

28. ►Timing of industrial disturbance on winter ranges

Oil well construction has been shown to influence habitat use and distribution of elk (van Dyke and Klein 1996). Mountain sheep (*Ovis canadensis*) have been shown to respond dramatically to helicopter disturbance, changing habitat use, increasing risk of predation, and creating nutritional stress (Bleich et al. 1994). Human disturbance can disrupt ungulate aggregations and reduce group size

(Manor and Saltz 2003). Understanding the timing of industrial activity on ungulate behaviour and use of winter ranges is necessary information for mitigating the consequences of industrial development.

29. ►Cougar harvesting study-quota-setting protocol √

Cougar populations appear to have increased in several parts of Alberta based on reports from trappers and hunters. ACA pays compensation to producers whose livestock has been killed by cougars, with up to 100% of the market value of the livestock being paid. In some localities cougars have been found to decimate local bighorn sheep herds (Ross et al. 1997). Laundré & Clark (2003) have developed a metapopulation approach for management of cougars but this seems unlikely to have relevance for management of cougars in Alberta where populations are contiguous and continuous through the extent of their range, and where there is substantial movement of animals throughout the range (Biek et al. 2003). I have recruited a new Ph.D. student, Kyle Knopff, who received his M.Sc. from the University of Calgary this spring, to work on cougar population ecology and management. He will begin his doctoral program this summer (2004).

30. ►Predator monitoring research √

Nathan Webb is developing a wolf population inventory method involving aerial survey and snow track counts for his M.Sc. thesis research in the central east slopes of Alberta. This project is funded by ACA's Grant Eligible Conservation Fund, supervised by Dr. E. H. Merrill in the Department of Biological Sciences at the University of Alberta.

31. ►Small woodlots--parklands √

Trisha Swift has been doing ACA-funded graduate study with Dr. Susan Hannon on forest fragmentation and loss of bird species in eastern Alberta. In another M.Sc. thesis, Ambrose (2002) examined the consequences to birds and amphibians of cattle grazing in parkland habitats associated with wetlands, supervised by Dr. Cindy Paszkowski, Department of Biological Sciences at the University of Alberta. Our understanding of the parklands ecosystem remains weak despite these research efforts; additional work, e.g., on mammals, is warranted.

32. ►Black bear hunting study √

This study evaluating the effects of baited spring bear hunting on black bear social structure and demography is being conducted by Sophie Czetwertynski as her Ph.D. thesis under the direction of the ACA Chair. A website for this project can be found at: http://ursus.biology.ualberta.ca/blackbears/

33. ►RSF models for bird distributions √

This is an active area of research by Dr. Fiona Schmiegelow in the Department of Renewable Resources at the University of Alberta with focus on passerine fauna in boreal forests of Alberta. Papers that develop this approach include Vernier et al. (2002) and Boyce et al. (2002).

34. ►Harvesting models for big game populations √

Postdoc Cailin Xu is assisting the ACA Chair with models for mule deer (*Odocoileus hemionus*), elk, and moose in Alberta. A workshop was held on these models in 2003. Model refinement and validation is continuing with anticipated completion in late 2004 or early 2005. When completed, models will be distributed to SRD biologists in the province to assist with quota setting for these 3 species.

35. ►Aerial survey sampling for elk √

Jim Allen, biologist for SRD in Rocky Mountain House is pursuing this project for his M.Sc. thesis in the Department of Biological Sciences at the University of Alberta. Sightability corrections using the Idaho model have proved quite effective for Alberta applications. Continuing work is planned to develop model-based sampling approaches for elk aerial surveys.

36. ►Mountain goat (*Oreamnos americana*) habitat models for Alberta

Resource selection functions have been used successfully to model goat habitats in Colorado (Gross et al. 2002), but such tools have yet to be developed for Alberta habitats. Methods for aerial survey have been refined for Alberta (Gonzalez-Voyer et al. 2001), and detailed field studies have reinforced the importance of forage quality for growth of kids and recruitment of females based on fecal crude protein (Cote and Festa-Bianchet 2001). RSF models for mountain goats in Alberta would be a useful management tool for conservation planning and anticipating the consequences of cumulative effects of industrial development (Johnson et al. 2004). Habitat modeling with GIS interface is underway in northern British Columbia; see website: (www.ardea.ca/Projects/Recent%20Projects.htm).

37. ►Fragmentation w/game fences

Rapid expansion of game ranching in Alberta during the 1990s led to the wide-spread construction of tall fences that could contain deer and elk. These fences function as barriers to movement for wild ungulates potentially blocking seasonal migration routes. Little is known about the consequences of habitat fragmentation by game fences to deer, moose, and elk in Alberta.

38. ►Expansion of timothy (*Phleum pratense*) and other exotic plants on elk winter ranges.

Several species of exotic plants have been known to invade elk winter ranges and seriously reduce the capacity of the range to support animals through the winter (Townsend 2004). In southern Alberta spotted knapweed (*Centaurea maculosa*) has invaded from Montana and has become a serious problem along the Belly, St. Mary, and Milk Rivers. Scattered infestations of spotted knapweed have been found in Crowsnest Pass, even in remote winter range areas. Blueweed (*Echium vulgare*) is another unpalatable exotic plant invading in southern Alberta. Timothy is also a concern because during winter it has little forage value even though it is used to make hay when harvested before senescence of the plants. Hiebert and Stubbendieck (1993) have developed a handbook to assist in targeting exotic plants for management and control.

39. ►Turkeys (*Meleagris gallopavo*)--negative effects?

The Merriam's turkey is an introduced species in southern Alberta, currently well established in the Porcupine Hills, Cypress Hills, Lees Lake, and Todd Creek areas. Little is known about the competitive effects on other birds, small mammals, or deer.

40. ►Mule deer declines/White-tailed deer increases in Alberta √

Susan Lingle is studying coyote predation on both mule deer and white-tailed deer in southern Alberta, funded in part by ACA's Grant Eligible Conservation Fund, resulting in a number of relevant publications (Lingle 2000, 2001, 2002, 2003; Lingle and Wilson 2001; Lingle and Pellis 2002). She is currently an Alberta Ingenuity postdoc working with the ACA Chair. Her earlier work for her M.Sc. with Val Geist at the University of Calgary focused on maladaptive gaits of hybrids between mule deer and white-tailed deer (Lingle 1992, 1993a, 1993b).

41. ►Compensation in game bird harvest

Compensatory natality and mortality is often cited as justification for hunter harvest (Boyce et al. 1999). Although convincing evidence for compensation exists for several species of game birds, the results are not always consistent and need to be documented to ensure sound management (Ellison 1991).

42. ►Model-based sampling/dist and abundance √

Habitat models, especially RSFs, often have high predictive capability (Boyce et al. 2002). Model-based sampling protocols can take advantage of this predictive power in developing more efficient sampling protocols for population estimation. James Allen is developing such a model for elk in the central east slopes under the supervision of Dr. E. H. Merrill. Another project is planned to reduce

sampling effort for estimation of grizzly bear abundance and trend using DNA methods (Mowat and Strobeck 2000), in a collaboration involving John Boulanger, Gordon Stenhouse, Dr. Subhash Lele (statistician, University of Alberta), and the ACA Chair.

43. ►Methods for small mammal survey √

Track count methods have been adapted from the Finnish triangle routes (Lindén et al. 1996) for use in an Adaptive Management Experiment (www.AMEteam.ca) study to document cumulative effects of industrial development on mammals, although the method does not appear suitable for mammals smaller than marten (*Martes americana*). A report on this project has been completed and can be obtained from Dr. Erin Bayne (bayne@ualberta.ca), Department of Biological Sciences, University of Alberta.

44. ►Low moose density in northwestern Alberta

For some unknown reason, moose densities in northwestern Alberta near High Level are chronically low, and the reasons for this low density are not understood. Nutrition has been suggested as a cause, but no research has been conducted to document such an effect.

45. ►Anthrax outbreaks in Alberta √

Although anthrax in livestock is declining worldwide, it remains endemic in several wildlife populations including bison and other wildlife in Wood Buffalo National Park (Hugh-Jones & de Vos 2002). An analysis of a 1999 outbreak of anthrax that impacted farms in the white zone of Alberta was studied using a geographical information system (GIS), finding that the disease was particularly prevalent in areas with poorly drained organic soils (Parkinson et al. 2003). Recent DNA methods permit identification of local strains of the disease.

46. ►White-tailed deer mortality near Edmonton

The white-tailed deer is an abundant and important game species in central Alberta. Sources of non-hunting mortality for this population are not understood, however. More complete information on the seasonal schedule of mortality could help to identify possible management approaches, and help to explain local variation in abundance. Such an investigation would necessarily entail radiotelemetry. New methods for survival analysis enhance our ability to draw strong inferences from telemetry data (Johnson et al. 2004).

47. ►Moose survey techniques √

Alberta Fish and Wildlife now uses a modified Gasaway method for moose population estimation, which appears to yield reliable estimates of abundance

(Gasaway et al. 1985; Lynch and Shumaker 1995). In some instances surveys could benefit from sightability corrections for which methods are well developed (Steinhorst and Samuel 1989).

48. ►Harlequin (*Histrionicus histrionicus*) duck status study √

Four Alberta Fish and Wildlife reports on harlequin ducks have been published with assistance from ACA (Kneteman & Hubbs 2000, MacCallum 2001, Smith 2001a, 2001b), and several status reports for Banff National Park and the Kananaskis Country by C. M. Smith can be found at the Parks Canada website: (http://www.praxis.ca/banfftwinning/resourceinformation.htm#HarlequinDucks). A national recovery plan for the species in eastern Canada has been completed (www.speciesatrisk.gc.ca/publications/plans/harlequin_e.cfm). In addition to the monitoring and status reports, behavioural studies have been conducted on harlequin ducks in breeding streams in Alberta (Smith et al. 2000).

49. ►Coyote predation on pronghorn √

A study was initiated at the Suffield Range, but was not completed. Nevertheless, but this aspect of pronghorn ecology will become a part of the new series of studies at the University of Calgary supervised by Dr. Cormack C. Gates.

50. ►Otter (*Lontra canadensis*) status and harvest study

River otters have been expanding their distribution in Alberta, especially into west-central portions of the province (Poole & Mowat 2001). Current practice often entails opening a trapping quota for otters after otters are captured accidentally by trappers indicating that a harvestable population may exist. Independent methods for evaluating distribution and abundance are required to develop sound management practices for otters. The Alberta Trappers Association has repeatedly indicated the need for such a research program.

51. ►Long-billed curlew status/management √

A status report on the long-billed curlew has been completed with assistance from the ACA (Hill 1998), and monitoring is being conducted by Alberta Fish & Wildlife staff.

52. ►Methods for boreal bat inventory √

Sonic bat detectors have been used in Alberta, and bias associated with detecting bats in various habitats has been studied recently (Patriquin et al. 2003). In addition, several recent papers on bat work done in Alberta have appeared including bat use of riparian habitats in SE Alberta (Holloway and Barclay 2000), bat use of habitats as influenced by silvicultural practice in boreal

forests of northern Alberta (Patriquin and Barclay 2003), and rock crevice site selection by big brown bats (*Eptisicus fuscus*) in SE Alberta (Lausen and Barclay 2000).

53. ►Elk depredation conflicts in Alberta

Elk use of haystacks and alfalfa crops continues to create depredation problems in western Alberta. Applied research on methods to deter such depredation could be a cost-effective way to reduce losses to farmers. Although no research on this topic has been published on work done in Alberta, a recent study from Wyoming (Van Tassell et al. 1999) may yield useful insight for managers. Experiences in Wyoming with winter provisioning of elk are to be avoided (Boyce 1989) and local fencing is an option that probably is more practical with fewer long-term consequences. Using geographical information systems (GIS) and habitat modelling to map areas of conflict might offer insight into how habitat management might be used to reduce elk depredations.

54. ►Egg removal effects on Whooping Cranes (*Grus americana*) √

During 1967-1996 eggs were removed from whooping crane nests in Wood Buffalo National Park to facilitate captive rearing programs and foster rearing by sandhill cranes (*Grus canadensis*). Concerns by Parks Canada that these egg removals might have jeopardized nest success were unfounded and remarkably nests with 2 eggs actually produced fewer surviving chicks on average than those in which an egg was removed (Boyce et al. 2004).

55. ►Wolverine (*Gulo gulo*) status and conservation √

Peterson (1997) prepared a status review for wolverines in Alberta, a species that has been designated “data deficient.” An Alberta *Species at Risk Report* supported in part by ACA reviews methods for assessing the distribution and abundance of the species (Mowat 2001). Wolverines tracks were detected during a road-crossing study in Banff National Park (Alexander and Waters 2000). Jason T. Fisher, Alberta Research Council, was funded by ACA to conduct survey using hair sampling and remote cameras. With approximately 11,000 trap nights at 95 sampling locations surveyed during 2003-2004, no wolverines were detected suggesting a very low density of wolverines throughout the area sampled in the northern east slopes. Even though the species occurs at low densities home ranges and dispersal distances are large resulting in substantial gene flow among populations across northern portions of their range in North America (Kyle and Strobeck 2002). However, southern peripheral populations, e.g., in the southern Rocky Mountains, contain greater genetic structuring suggesting that they may require careful protection to avoid extirpation (Kyle and Strobeck 2001).

56. ►Analysis of breeding-bird survey √

BBS data have been compiled over vast areas and include valuable information on trends in breeding birds. Although these data have been used to identify declines in species over large areas, finer-scale analysis to document the consequences has seen limited attention. One study examined BBS routes along the boreal fringe in central Alberta and documented a substantial decline in avian diversity, which were attributed to habitat loss (Cumming et al. 2001). More opportunities exist to relate these data to the consequences of agricultural and industrial developments on the landscape.

57. ►Furbearer inventory-statistics √

Furbearer harvest records in Alberta 1977-1999 were synthesized in an *Alberta Species at Risk Report* (Poole & Mowat 2001) that included a number of recommendations for methods to improve the quality of data. Shevenell Mullen has been supported by ACA's Grant-Eligible Conservation Fund and the Alberta Ingenuity Fund to study harvest patterns for marten in Alberta's east slopes. Careful cross checking of SRD data files has revealed some disturbing inconsistencies in the records. Mullen's thesis, supervised by the ACA Chair, should be completed by the end of year 2005.

58. ►Rattlesnake (*Crotalus viridis*) ecology and management in SE Alberta √

A status report on prairie rattlesnakes was completed with assistance from ACA (Watson and Russell 1997). Research funded by ACA is being conducted out of the University of Calgary by M.Sc. student Dennis Jørgenson on a project entitled "Effects of multiple land use on movements and habitat use of migrating prairie rattlesnakes: Improving the certainty of wildlife management in the Grasslands Natural Region of Alberta." Completion of the project is anticipated in 2006.

NEW PROJECTS IDENTIFIED IN 2004

PROJECTS ALREADY INITIATED

59. ►Pronghorn aerial survey data analysis

Cormack C. Gates, University of Calgary, has initiated new research on pronghorn that will include a systematic analysis of existing aerial survey data on pronghorn. Aerial counts can be interpreted using distance sampling methods (Buckland et al. 2001) to obtain population estimates.

60. ►Landscape change and grizzly bear response

Grizzly bear studies through the Foothills Model Forest (FMF) based in Hinton, Alberta have found confounded responses to roads because roads often occur in high-quality habitat (see Nielsen et al. 2002). To evaluate the response of bears to roads independent of habitat covariance, Carrie Roever is initiating an analysis to evaluate how individual bears respond to landscape changes occurring in the FMF study area, using data collected during 1999-2003. This is a new M.Sc. study supervised by the ACA Chair in collaboration with Gordon Stenhouse with FMF.

61. ►Model-based sampling for Grizzly bear population monitoring

DNA methods for inventory of grizzly bears (Mowat & Strobeck 2001) are non-invasive but currently very expensive to conduct. Sound management of grizzly bears in Alberta requires that we have better population inventories. Model-based sampling offers promise to yield indices of population change with much reduced effort by marrying resource selection functions with mark-recapture methods. Scott Nielsen, John Boulanger, Mark Boyce, and Gordon Stenhouse are collaborating on this effort initially but we are seeking a graduate student in statistics who can develop a model-based sampling design.

62. ►Grizzly bear RSF model robustness

Habitat-selection models have been constructed for grizzly bears in the Yellowhead study area south of Hinton, Alberta in the Foothills Model Forest. Our intent now is to evaluate these models by collecting radiotelemetry data on grizzly bears in areas further south. This year 22 bears have been radiocollared from the Brazeau River to the U.S. border. We do not know how spatially robust the models are for application in other study areas. This project will be done by Scott Nielsen as a postdoc supervised by the ACA Chair, working with Gordon Stenhouse on the Foothills Model Forest Grizzly Bear Project.

63. ►West-Nile virus effects on sage-grouse and other birds

In August and September 2003, 26% of radiocollared female sage-grouse in SE Alberta died from West Nile virus. Additional data from Wyoming, Saskatchewan, and Montana indicate that comparable levels of mortality were documented in other populations. Experimental treatment of birds with WNv indicate high lethality in sage-grouse, which could be devastating to conservation efforts for this endangered species. A publication reporting these results is in press (Naugle et al. 2004). In addition, however, additional work is needed to document the consequences of WNv to non-corvid species, and alternative management strategies need to be assessed. A new M.Sc. student, Jen Carpenter, was recruited this spring to initiate studies on sage-grouse ecology related to WNv with support from Alberta Sustainable Resource Development.

64. ►Badgers in dry mixed-grass prairies in ecosystem context

ACA is supporting a project assessing attitudes, experiences and practices of landowners and ranchers relative to the American Badger (*Taxidea taxus*) in Alberta by Sian Waters. Badgers are often maligned by ranchers because of the holes that they dig, but these holes can be important habitats for other species. Karl Larson at the University College of the Cariboo has been studying badgers in BC where they are endangered (website: http://www.cariboo.bc.ca/news/newWork/PraxisPDFsScrn/P15-18Talbot.pdf)

65. ► Fish Assemblages in Lac La Biche: Interactions with double-crested cormorants (*Phalacrocorax auritus*)

Controversy continues to surround the effect of cormorants on fisheries, so this ACA-funded project will provide some much-needed data. This project supported by ACA's Grant-Eligible Conservation Fund is supervised by Cindy Paszkowski, Department of Biological Sciences at the University of Alberta.

66. ►Linking Ungulate population dynamics to fire and wolf predation: the Ya Ha Tinda Elk and Wolf Project

Mark Hebblewhite is developing spatially structured models of wolves and their ungulate prey in the Ya Ha Tinda Ranch and adjacent lands. Concerns exist about the effects that wolves and land use are having on the migratory patterns of elk in the area where wolves and elk move in and out of the northern portion of Banff National Park. This project is supported by ACA, Parks Canada, Challenge Grants in Biodiversity, Rocky Mountain Elk Foundation, Canon-National Parks Service Science Scholars for the Americas Scholarship, Foothills Model Forest, Patagonia, Alberta Enhanced Career Development Program, and Yellowstone to Yukon Initiative, Mountain Equipment Coop and is supervised by E. H. Merrill at the University of Alberta.

67. ►Dynamics of harvested wolf populations in the east slopes

Nathan Webb at the University of Alberta is conducting his M.Sc. thesis research on wolf population response to hunting and trapping pressure in west-central Alberta. Wolves in this area have been implicated in maintaining ungulate herds at low densities, but are also valued by trappers as a recreational resource and may be important to maintaining viable numbers of wolves in Banff and Jasper National Parks. Provincial game laws currently allow unlimited take of wolves throughout most of the year, prompting concerns that current management strategies do not address the diversity of needs imposed on this population. Supervised by E. H. Merrill, Nate is collaborating with provincial biologists to collect information on wolf density, pack- and population-level response to harvest pressure, and to develop a population model to project wolf and ungulate

populations under different wolf management regimes. Support comes from NSERC and NSF, on which the ACA Chair is co-investigator.

In addition to this project, Robert Lessard is developing predator-prey models for wolves, caribou, and moose in the northern east slopes of Alberta for his Ph.D. under the supervision of Fiona Schmiegelow in the Department of Renewable Resources at the University of Alberta. Also, Fiona is supervising Lalenia Neufeld who is investigating the effect of wolves on the declining Little Smoky caribou herd in western Alberta. A website describing these 2 wolf studies is: http://www.rr2.ualberta.ca/Staff/fschmieg/grads.htm

68. ►*Shepherdia* ecology

Buffaloberry is an important source of berries for grizzly bears in Alberta. Knowing what silvicultural practices enhance buffaloberry growth and berry production can enhance habitats for bears. This project by Scott Nielsen is supported by Weldwood, supervised by the ACA Chair.

69. ►Bighorn conservation genetics

Recently published work by David Coltman et al. (2003), Department of Biological Sciences, University of Alberta have shown that continued trophy hunting of large male sheep can result in selection sufficient to cause genetic diminuition in horn size. Although there may not be serious conservation ramifications, this can have important consequences for trophy sheep huntering.

RESEARCH NEEDS

Projects were ranked using the SMART process (Ralls and Starfield 1994) with numerical scores listed in Table 1. Included in this listing are projects that were identified during the 1990-2000 prioritization process which remain as research needs in 2004.

1. ►Climate change effects on conservation strategies

During the past few years, evidence for climate change, resulting from discharge of CO_2 and other greenhouse gases, has become overwhelming. The changes predicted for various portions of Alberta vary depending on the Global Circulation Model used to generate the predictions, but generally we can see warmer temperatures and greater variability in precipitation regimes. Little thought has gone into the conservation ramifications of climate change. Clearly habitats will be change, species distributions may be altered, optimal harvest policies may require adjustment, and more species are likely to join the ranks of species at risk. For example, we have already witnessed conifer encroachment into bighorn sheep habitats in subalpine ranges. Interpreting GCM predictions in conservation context will help Albertans to be prepared for inevitable changes in

conservation strategy. Climate change scenarios for Alberta can be obtained from the following website: http://www.cics.uvic.ca/scenarios/

2. ►Woodland caribou/wolf/moose & white-tailed deer interaction

Development in the forestry and oil/gas sectors in northern and western Alberta has resulted in extensive habitat loss and consequent population declines of woodland caribou (McLoughlin et al. 2003). One of the serious effects on caribou results from timber harvest and seismic line construction that enhances habitats for moose (James and Stuart-Smith 2000). This in turn appears to result in increased wolf densities that then cause higher mortality in Alberta's threatened caribou. Some of the pieces to this multi-species interaction with landscape change need careful documentation. In particular, a management strategy for dealing with higher moose numbers is to increase the harvest quota for moose in areas where caribou are found. We need to document the effectiveness of this management tactic for moose and whether it actually reduces wolf numbers, and enhances caribou survival. Manipulation of harvest quotas for moose could be manipulated experimentally in a way that would ensure sound inference.

3. ►Wildlife benefits to soft access at production facilities

Best management practices for oil and gas extraction involve reducing the industrial footprint and using technologies that minimize environmental damage. In addition, access management can be effective at reducing consequences for certain wildlife including grizzly bears, elk, and moose. Research to evaluate the cost effectiveness of these measures and wildlife benefits could help to guarantee that oil and gas development in Alberta progresses in an environmentally sensitive manner. Working with oil and gas companies to use an experimental design on large landscapes will ensure that we have sound scientific basis for future development.

4. ►Landscape conditions and population status of grizzly bears

Alberta's grizzly bear management plan (1990) uses landscape status as of 1988 to extrapolate habitat potential for grizzly bears across the range of the species in western Alberta. Since then we have not seen an update of landscape conditions even though there has been extensive timber harvest and oil/gas development altering landscapes, especially on Alberta's east slopes. This year 2 additional hair sampling projects are underway to estimate grizzly bear densities in areas previously unsampled. To be able to make use of these density data and to extrapolate population size we require an update of habitat distribution. Although this will be an extensive undertaking, remote sensing information exist to be able to conduct this analysis. RSF models can be used to then extrapolate the abundance of bears province wide, although to do this well will require more detailed investigations in the boreal forest regions of the bear's

distribution (see project ranked #16 below). This is a priority research need identified by the Grizzly Bear Recovery Team.

5. ►Waterfowl nest predators

Nest predators have been shown in Manitoba, South Dakota, and North Dakota to have large effects on waterfowl nesting success, and predator-control programs to reduce red fox, coyotes, skunk, and raccoon densities can be effective at enhancing waterfowl production. Evaluation of such a program in Alberta may be worthwhile albeit possibly controversial because of public aversion to predator control. A non-invasive study to identify habitats with least predation effects could be done by using telemetry to construct RSF models for predators in waterfowl nesting areas. This remains as a priority wildlife research need in Alberta. See topic discussion under #10 rank from 1999-2000 list above including work by Rob Stavne and Jeff Warren's Ph.D. thesis work out of the University of Montana ongoing in Buffalo Lakes area.

6a. ►Elk declines and heavy grazing by cattle in the Highwood Valley

Agricultural intensification in Alberta is having negative consequences for wildlife in a number of areas. One area in which elk and cattle competition appears serious is in the Highwood Valley. Competition between elk and cattle has been studied elsewhere (Miller 2002), including some detailed experimental work (Hobbs et al. 1996). Livestock management practices can reduce the consequences of cattle on elk, but how cattle are distributed, timing of use, and intensity of stocking can have variable impacts. Therefore, to understand optimal cattle management to minimize conflicts is site specific and requires site-specific investigation.

6b. ►Bighorn and cattle grazing on Sheep River Wildlife Sanctuary

Bighorns and cattle are less often in competition than elk and cattle largely because sheep occupy higher elevation ranges that receive little cattle grazing. However, in a few places the ranges for these 2 species overlap and competitive interactions can occur, as well as risk of disease transmission from cattle to bighorns. In some areas pneumonic pasteurellosis that can cause heavy mortality in bighorns. Treatment methods using biobullets have been used successfully to vaccinate sheep with *Pasteurella haemolytica* supernatant vaccine (McNeil et al. 2000). There are no published reports that indicate that contact between cattle and bighorns can increase risk of pneumonic pasteurellosis in bighorns, but there is current research on this topic in Washington.

N.B.: Same rank as previous project.

7. ►Restoration of habitats for grasslands species

The ultimate test of our understanding of sage-grouse habitats would be if we were able to restore cultivated lands to support greater sage-grouse. To do so we need to better understand the consequences of alternative grazing regimens and the role of fire (Wisdom et al. 2002), especially for the unique silver sagebrush (*Artemisia cana*) habitats occupied by sage-grouse in Alberta. Methods for planting silver sagebrush have been studied in Saskatchewan, and safe site conditions for seedlings appear crucial to successful establishment (Romo & Grilz 2002). The spread of exotic plants on reclamation sites creates challenges for effective restoration of shrubland habitats.

8. ►Vital rates mapping to identify critical habitats for species at risk

Density and distribution can be misleading indicators of habitat quality for a species (van Horn 1983, Boyce & MacDonald 1999), and true identification of quality habitats may require mapping of survival and reproductive success. GIS technology allows us to do a more complete job of mapping, and new survival analysis techniques facilitate modeling survival as a function of landscape covariates (Johnson et al. 2004). These methods are particularly well suited for species that have been studied using radiotelemetry, and offer the most rigourous picture available for components of crucial habitats for species at risk.

9. ►Grazing-lease wildlife management

Crown lands in Alberta are managed by Public Lands (SRD). Increasingly, wildlife values on these lands are being challenged by industrial development especially for natural gas with recent proposals to begin coal-bed methane extraction. In addition, crown lands have been sold or traded despite high wildlife values on some of these properties. Engaging the ranchers holding grazing leases in developing the wildlife potential of these lands is likely to be facilitated by options that would yield economic benefits from such management. There is a need to evaluate options for charging a fee for hunting, improving access on grazing leases especially in light of recent changes to regulations, and wildlife valuation studies. Public opinion surveys of alternative strategies are also needed.

10. ►Alternatives to beaver control on the East Slopes

On a number of watersheds in Alberta's east slopes, beaver control is viewed necessary to manage fisheries. However, negative consequences of altering the hydrological regime by removing beavers are evident in a number of areas, e.g., in the Whaleback. Streams cutting into meadows reduced wildlife as well as livestock values, and may often be counter productive to fisheries management as well. A systematic evaluation of beaver control practices is needed, perhaps in conjunction with the Cows and Fish program.

11. ►Feral horse interations with native ungulates in the East Slopes

Sizable populations of feral horses exist in a number of areas of the east slopes of Alberta. Little is known about the interaction between horses, elk, moose, and deer in this area. Revisions to the management program for feral horses might be warranted, but few data exist documenting the distribution and abundance of the horses.

12a. ►Grazing experiments on Alberta's prairies

Intensive livestock grazing has been shown to have detrimental consequences for a diverse array of wildlife. Conservation consequences of improper livestock grazing is likely to be most severe in the southeastern prairies of Alberta that host the majority of the province's species at risk. Efforts to initiate experimental manipulations of grazing practices have been resisted by Public Lands and by local ranchers (Aldridge et al. 2004), but such research is urgently needed to ensure persistence for Alberta's species at risk. Lee Foote's graduate student Christine Rice (2003 MSc.) examined Odonates (dragonflies and damselflies) as bioindicators in relation to grazing intensity on the Eastern Irrigation District around Brooks, AB. She found intensive grazing to reduce habitat quality for littoral invertebrates through structural changes to emergent vegetation yet no discernible changes to water quality from urine and feces.

Christine Rice sampling water quality for invertebrate habitat as part of a bioindicator study in the Eastern Irrigation District, near Brooks, Alberta.

12b. ►Wildlife habitats on private lands survey

A project evaluating economic strategies for engaging landowner participation in wildlife management is underway by Lee Foote, in the Department of Renewable Resources at the U of A, but this is not intended to be a comprehensive survey. We do not have a good understanding of wildlife resources on private lands in Alberta, although there are continuing efforts such as the Native Prairie Stewardship Program and the Cows and Fish program that work closely with landowners to advocate sound wildlife management. See discussion under rank #24 from previous wildlife needs list above.

13a. ►Status of the white-winged scoter (*Melanitta fusca*) in Alberta

See discussion and references under topic ranked #25 in the 1999-2000 list of wildlife research priorities in Alberta. Research by Eric Butterworth, working with Ducks Unlimited with the HEAD project is underway with studies of white-winged scoter and lesser scaup on boreal ponds.

13b. ►Mountain pine beetle (*Dentroctonus ponderosa*)/caribou interactions

Epidemics of mountain pine beetles have been a serious concern in British Columbia, and the beetles are now appearing the the Spray Lakes area, and further north in the Bloodroot Creek/Kakwa/Upper Jackpine River area. There may be positive consequences for some species resulting from timber management in response to management for the beetles (Steeger & Hitchcock 1998), but how to interface management for wildlife has not been well developed. For example, stand thinning can ameliorate mountain pine beetle outbreaks (Powell et al. 1998), but this may alter wildlife habitats. Particular concern has been anticipated relative to caribou management where beetle kills and subsequent salvage logging might result in habitat loss. The extent of wildlife ramifications resulting from forest management for mountain pine beetles in Alberta may needs attention.

14. ►Bighorn life-history responses to mine site reclamation

Management strategies for bighorn populations associated with mine-site reclamation has been a controversial topic in recent years. Bighorn sheep have thrived on several mine reclamation sites in western Alberta. Rapid growth of males has occurred along with younger age at harvest. Informed management could benefit from detailed studies of the demography and life-history characteristics of these populations.

15. ►Expansion of timothy (*Phleum pratense*) and other exotic plants on elk winter ranges.

See comments above from 1999-2000 list, item rank #38. Spotted knapweed may be a more serious concern than timothy in southern Alberta. A model has been developed that can help to identify places where spotted knapweed is likely to invade (Gillham et al. 2004). Research on biological control may hold promise, for example, Story et al. (2004) have evaluated a lepidopteran larvae, *Pelochrista medullana,* for biological control of spotted knapweed that might be effective in Alberta.

16. ►Boreal grizzly bear habitat ecology

Grizzly bears in NW Alberta occur in boreal forest habitats where no habitat research has been conducted. Because this is an area that has sustained hunter harvest, better understanding of habitat relations is needed. GPS-radiotelemetry work to build RSF models would be of particular value so that habitat/population models can be developed to anticipate the consequences of alternative land management practices.

17. ►Effectiveness of the Habitat Stewardship Program (HSP)

The Canadian Wildlife Service has implemented the HSP allocating $45 million over 5 years for habitat protection and improvement for species at risk wildlife, often through agreements with provincial programs. In many instances it is anticipated that a number of non-target species have benefited from this program as well. What is needed is a systematic evaluation of the HSP program to date and an assessment of its effectiveness for wildlife conservation. Such an analysis could have important ramifications for HSP implementation in the future.

18. ►Multi-species conservation strategies

Habitats for any wildlife species overlap with those for other species. Identifying assemblages of species in greatest need for conservation attention may help to target habitats where protection or management would have greatest value (Rodrigues et al. 2004). Such a strategy might have broader ramifications if focused on ecosystems services; an idea that has been termed “keystone ecosystems” (deMaynadier & Hunter 1997). A principle of ecosystem management is that benefits of conservation action are greater if based on a multi-species approach versus a single-species approach (Boyce and Haney 1997, Fleming & Alexander 2003), yet we seldom can understand patterns of multiple species without understanding the autecology of the constituent species. For example, gap analysis using GIS has been used to identify localities of highest species richness where many species distributions overlap, but such an approach must be married to species-level assessments of viability for at-risk species (Noon et al. 2003). One of the risks of a gap-analysis approach is that

localities of high richness are where distributions overlap but these are not necessarily prime habitats for most of the species represented. Similarly, developing conservation priorities in Canada is challenged by the fact that a majority of species at risk are peripheral species with most of the range for these species existing south of the border. This topic overlaps with topic #15 which is currently being addressed with the "MULTISAR" Milk River Basin Habitat Stewardship program involving Habitat Suitability Index (HSI) models for species of management interest in the Milk River basin (Downey et al. 2004). Comprehensive multi-species approaches for habitat conservation are in need of further evaluation and development.

19. ►Fragmentation w/game fences

See the item ranked #37 in the 1999-2000 priority list above. Drs. Foote, Boyce, Schmiegelow, and St. Clair produced a white paper on issues relating to proposed cervid harvesting preserves (CHPs) and featured concerns about game fences as a landscape fragmentation feature.

20. ►Otter status and harvest study

River otters have been expanding their distribution in several areas in Alberta. Current practice often entails opening a trapping quota for otters after otters are captured accidentally by trappers indicating that a harvestable population may exist. Independent methods for evaluating distribution and abundance are required to develop sound management practices for otters. The Alberta Trappers Association has repeatedly indicated the need for such a research program. See discussion at rank #50 in the list above.

21. ►Grazing experiments in parklands

The aspen parkland is an extensive ecoregion in Alberta, but the most intensively modified by humans. Tillable lands have been extensively converted to cropland and other areas are intensively grazed by livestock, especially cattle. The extent of ecological consequences of this livestock grazing is not fully appreciated, and merits experimental study to evaluate alternative grazing regimens. Current work is underway documenting patterns of grazing in the parkland and associated waterfowl and wetland dependent birds, with preliminary results suggesting that nesting success is highest at sites with moderate grazing intensity. Two projects sponsored by Ducks Unlimited and funded by the Institute for Wetland and Waterfowl Research, and the North American Waterfowl Management Plan (NAWMP) partnership in Alberta are reviewed at: (www1.agric.gov.ab.ca/$department/newslett.nsf/all/acc2534?OpenDocument).

22. ►Overwintering waterfowl in Alberta

Power generating facilities in central Alberta sustain increasing numbers of waterfowl especially Canada geese (*Branta canadensis*) and mallards (*Anas platyrhynchos*). In some areas, e.g., Keep Hills, geese are provisioned in winter which further encourages the birds to attempt to overwinter. However, over-wintering goose populations vary substantially from year-to-year; cold weather can result in heavy losses. Extent of losses is not well documented. Methods for deterring birds from staying through winter could be the subject of a behavioural ecology study of overwintering Canada geese and ducks.

23. ►Invasive plants and their ecological consequences

This topic overlaps with priority #15 that focuses on elk winter ranges. But clearly invasive plants are a much broader concern than just on elk winter ranges. Many exotic plants have been introduced for agriculture including timothy, smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratense*), sweetclover (*Melilotus* spp.), white clover (*Trifolium repens*), crested wheatgrass (*Agropyron desertorum*) and reed canary grass (*Phalaris arundinacea*). Additionally several of these species are used in reclamation efforts and roadside stabilization, resulting in widespread distribution throughout the province. Some of these species have much lower value for wildlife that the native plants, and invasion can reduce the utility of wildlife areas for wildlife. Methods for control or to prevent spread need to be understood to facilitate wildlife habitat management.

24. ►Timing of disturbance on winter ranges

See discussion and references under rank #28 from the 1999-2000 priority listing of wildlife research needs.

25. ►Model of conservation prioritization for SARA funds allocation

Implementation of the Species At Risk Act has been allocated $33 million over 2 years in Budget 2003. How this implementation will take place has yet to be determined, and the Canadian Wildlife Service would like assistance in the form of a model that could evaluate the consequences of alternative strategies for implementation. Reviews of the effectiveness of the Endangered Species Act and Habitat Conservation Plans (HCP) in the United States could serve as templates for such an evaluation (Moser 2000, Doremus & Pagel 2001, Gerber & Hatch 2002, Wallace 2003, Curtis & Davison 2003).

26. ►Economics of species at risk

A common perception in Alberta is that the new Species as Risk Act is an economic burden and threat to landowners who might discover an endangered species on their property. An alternative view is that there exist ecotourism opportunities that might yield economic benefits for landowners. Clearly

economic considerations will be taken into account in endangered species management (Shogren et al. 1999, Hughey et al. 2003) as well as non-consumptive values (Alexander 2000). An economic assessment of potential opportunities versus development limitations with negative opportunity costs would provide a more realistic view (Parkhurst & Shogren 2003, Sinden 2004).

27. ►Methods for reducing wolf depredation on livestock in SW Alberta

Wolf control by lethal methods continues to be highly controversial (Mech & Boitani 2003), especially in agricultural areas of southwestern Alberta. Yet, there is a high correlation between the number of livestock depredated by wolves and the number of wolves killed by control efforts (Musiani et al. 2003). Evaluating methods for control of livestock depredation is crucial to maintaining wolves in agricultural landscapes. Wolf depredation in SW Alberta appears to be highly patch and sporadic. Use of fladry has proven effective in some circumstances (Musiani et al. 2003). Control efforts often attempt to target offending individual wolves. Whether removal of complete packs or simply reducing pack size can be more effective has been insufficiently evaluated.

28. ►Molecular genetic assessment of the spatial structure of populations of white-tailed deer and mule deer in eastern Alberta

Developing effective control measures for response to occurrence of CWD in Alberta requires an understanding of the spatial extent of mixing within and among populations. Spatial structuring of deer populations can be conducted using DNA techniques so that the most likely spread of the disease might be anticipiated. Samples could be taken from heads turned in for analysis, and depending on budget and study design, might benefit from some associated radiotelemetry monitoring of a sample of deer.

29. ►Ruffed grouse (*Bonasa umbellus*) population cycles in Alberta

Ten-year periodicity in ruffed grouse numbers has been documented in central Alberta (Rusch & Keith 1971), but there is a perception among field biologists that these cycles have stopped in NW Alberta. Predation by northern goshawks (*Accipiter gentilis*) has been hypothesized to be a driving force in the dynamics of ruffed grouse populations. Understanding the mechanisms and causes for wildlife's 10-year cycle in Alberta and throughout Canada continues to be one of the unresolved challenges in population ecology (Krebs et al. 2002).

30. ►Selenium toxicity associated with coal mines and reclamation

Selenium toxicity in trout has been recently documented associated with coal mines in Alberta's northern east slopes (Palace et al. 2004), but little work has focused on wildlife in the area. Selenium can be concentrated by vegetation on

coal-mine reclamation sites and is known to have toxic effects on reproduction and growth of wildlife.

31. ►Mountain goat habitat models for Alberta

See previous research needs list, rank #36.

32. ►Aversive conditioning of bears

A variety of aversive conditioning techniques have been used with mixed success on both black and grizzly bears including capture and release, rubber bullets, cracker shells, warning shots, and other fireworks (Rauer et al. 2003). Hunting has been shown to make bears more wary (Swenson 1999) but with greater restrictions on grizzly bear hunting in Alberta, alternative methods for aversive conditioning will need to be refined. Karelian bear dogs have proven to be effective for aversive conditioning of grizzly and black bears, and can be used to reduce human-bear conflicts (www.beardogs.org/kbds/). We have found Karelian bear dogs to be helpful when conducting field research on bears, greatly reducing the risk of dangerous encounter.

33. ►Peace-Athabasca Delta ecology and biodiversity

Despite the severe ecological consequences of the 2 dams on the Peace River in British Columbia, BC Hydro is proposing to build yet another dam that will further alter the flow regimes in the Peace-Athabasca Delta in Alberta. Water-level manipulations have been used to ameliorate consequences, and flooding associated with spring break-up appears crucial. Reduced water level fluctuations from dam outflows have been exacerbated by climate change resulting in a drying of the Delta. A number of studies have been conducted in the Peace-Athabasca Delta (including muskrat studies by Alberta SRD's ADM for Fish & Wildlife, Ken Ambrock), but what is needed is a synthesis of these studies into a comprehensive document. Also see a controversial counterpoint in the journal *Wetlands* by Alberta consultant Kevin Timoney who contends there is no dependable evidence that PAD changes are linked to the Bennet Dam.

34. ►Ecology of mosquito control for management of West Nile virus.

West Nile virus is causing a crisis for some birds, e.g., greater sage-grouse (Naugle et al. 2004). To control mosquito vectors of West Nile virus, wetlands are being treated, but we do not know the secondary consequences of such control programs for other species, e.g., leopard frogs. Alternative biological control methods to control mosquitos might exist.

35. ►Mule deer aerial survey methods

The modified Gasaway method for aerial survey used for moose population estimation in Alberta does not work well for mule deer. One method that appears to improve mule deer aerial surveys is to conduct a preliminary stratification flight to identify areas of mule deer concentration prior to conducting the surveys. But this increases the cost of the surveys. Development of alternative population estimation protocols for mule deer are needed to achieve reliable population estimates and variances in abundance.

36. ►Public attitudes towards chronic wasting disease

Despite extensive surveys of mule and white-tailed deer along the Saskatchewan border, CWD has not been found in deer in eastern Alberta. The public is largely poorly informed of the true risks of human health hazard associated with CWD, but the fear is that it might cause a prion-based disease similar to Crutchfield-Jacobs disease. Understanding public attitudes will help SRD to respond appropriately in the event that CWD is found in Alberta to minimize the consequences for deer management. A synthesis of available information on CWD has been coordinated by Wildlife Disease Centre in Saskatoon, and a report should be available soon.

37. ►Risk assessment for CWD

Because CWD and Bovine Spongiform Encephalopathy (BSE) are both caused by prions, concerns exist that CWD might be able to infect humans with Crutchfield-Jacobs disease. Outbreaks of CWD in Wisconsin and other parts of the United States resulted in huge publicity coverage and concerns by hunters about eating deer meat. On the other hand, CWD has been chronic in deer and elk herds of northern Colorado and SE Wyoming for 25 years and appears to be largely ignored by hunters except if the animal appears ill. We do not know how Alberta hunters might respond to a CWD outbreak and therefore cannot anticipate the appropriate management response to future occurrences of the disease. Developing a risk assessment and proposing alternative management strategies for a CWD outbreak will provide a framework for a reasoned response if and when the disease should reappear in Alberta. This topic was addressed in depth during an ACA & ACCRU sponsored Chronic Wasting Disease Conference in Edmonton on 11 January 2003 that engaged 350 attendees with international experts on CWD presenting current understanding of CWD biology.

N.B. We do not understand the mode of transmission for CWD and clearly this is an urgent research topic. However, we are reluctant to suggest that CWD be introduced into Alberta for the purpose of conducting such research and advise that this be done elsewhere, e.g., Colorado or Wyoming, where the disease already exists in a chronic infection within wild populations of deer and elk.

38. ►Analysis of breeding-bird survey.

See item ranked #56 on the list above for additional discussion and references. Although some research has been done using these data, there are many opportunities for further research, especially for documenting the consequences of landscape change on breeding birds.

39. ►Swift fox (*Vulpes velox*) mortalities associated with coyote trapping and snaring

Through an aggressive reintroduction program, a viable population of swift foxes has been restored to the grasslands of Alberta and Saskatchewan (Herrero et al. 1986, Moerenshlager 2002). Concern has been expressed by the environmental community that swift foxes may be killed by coyote trappers working the area, but the Alberta Trappers Association insists that trappers actually reduce swift fox mortality by removing coyotes that depredate the foxes (Kitchen et al. 1999). Kamler et al. (2002) showed that coyotes could be trapped in an area where swift fox were sympatric by adjusting the pan tension on #3 Victor Soft Catch traps so that only coyotes were caught. Similarly, trappers have told me that snares can be set so that swift fox are very unlikely to be caught. Interviewing trappers in the area and evaluating swift fox mortality during trapping season could be used to verify methods used by local trappers. Then, depending on the results of the study, education programs could be implemented to help coyote trappers avoid catching swift foxes.

40. ►Aerial survey inventory alternatives

High costs of using aerial survey methods for estimating large mammal populations have burdened wildlife program budgets for many years. Using novel sampling protocols or alternative population estimation methods might free funds for other wildlife conservation programs in the province. Such methods might engage local Fish & Game clubs, for example, in compiling systematic snow track data or other sorts of information that could be used as indices of abundance. More sophisticated model-based sampling protocols also might reduce costs for helicopter time (see topics #42 & 61 above).

41. ►Wainwright elk conflicts with agriculture

An elk herd on Camp Wainwright has expanded substantially in recent years and is beginning to create conflicts with local farmers on both Crown and private lands. Generally, farmers resent hay, forage, and cropland damage caused by elk (Lacey et al. 1993) and request that the herd be controlled by more liberal hunter harvests. Methods for deterring elk from using private lands could be studied as well as public attitudes toward the elk herd.

42. ►Elk depredation studies NW Alberta

See discussion and references for the topic ranked #53 in the 1999-2000 list of research needs.

43. ►Factors influencing white-tailed deer harvest distribution

Throughout most of Alberta, white-tailed deer are harvested on a general deer tag, giving the hunter free reign to travel anywhere in the province that they wish to hunt deer. To be able to manage deer harvests more effectively, managers need data on the factors that distribute the harvest including access to private lands, extent of public lands open to hunting, hunter density, proximity to urban centers, and deer population density.

44. ►Urban deer management in Alberta

Some urban localities in Alberta, especially in the Calgary area, have high densities of both white-tailed deer and mule deer. Although city dwellers enjoy viewing deer, problems arise because of road kills and depredations by deer on gardens and shrubs. In some areas, snipers using silencers have been used at deer feeding stations to reduce deer herds (http://www.inhs.uiuc.edu/chf/pub/surveyreports/mar-apr00/deer.html). Elsewhere, bow seasons have been opened in urban neighborhoods. Culling methods often require public educations programs to gain acceptance. Contraceptives have repeatedly proven to be expensive to administer and require continuing programs to keep deer herds in check (Cowan et al. 2003). Likewise translocation is an expensive and often results in heavy mortalities due to capture myopathy (Beringer et al. 2002). Public attitude surveys are often a good starting point to explore the possible acceptance of alternative methods for controlling urban deer populations.

45. ►Road-killed deer

Deer-vehicle accidents result in millions of dollars in insurance claims every year with especially heavy losses near Calgary. Developing comprehensive strategies for ameliorating these losses would offer obvious economic benefits, and ideally would be balanced against wildlife values (Nielsen, Anderson & Grund 2003). Included as alternatives in an experimental design might be increasing local deer harvests, modifying road-side vegetation, fencing, highway underpasses, signing, and deer deflecting devises. Funding for such a study should be available from insurance companies given the extent of losses.

46. ►How to identify keystone species

Identifying priorities for conservation action continues to be a complex problem. One proposal has been that conservation attention should focus on keystone species, i.e., species that have disproportionate influence in ecosystem structure or function (Simberloff 1998). Unfortunately, we do not have consistent criteria

for identifying keystone species. Development of methods and criteria for identifying keystone species could be useful for setting conservation priorities.

47. ►The value of peripheral populations in species-at-risk conservation

Peripheral populations often are lower in abundance but experience greater population fluctuations than those more centrally located within the species distribution (Vucetich and Waite 2003). As a consequence, genetic diversity is often low in peripheral populations as has been found in lynx (Schwartz et al. 2003), although genetic variation among peripheral populations is often greater, as has been documented in wolverines (Kyle & Strobeck 2002). Vucetich and Waite (2003) identify alternative hypotheses to help identify peripheral populations that offer new context for understanding the conservation value and vulnerability of peripheral populations. Remarkably, many species at risk actually persist in the periphery of their historic ranges (Channel & Lomolino 2000). Developing a comprehensive understanding of the value of peripheral populations is of particular importance in Canada where the majority of species at risk are peripheral to larger populations further south.

48. ►Sand dune ecology and management

Sand dunes occur in several areas of Alberta including southeastern portions of the province, at Canadian Forces Base Suffield, on the shores of Lake Athabasca and Lesser Slave Lake, and along the Athabasca River in western Alberta. Sand dunes were maintained naturally by disturbances including wind, ungulate trampling, and fire. Modern agricultural practices attempt to stabilize the dunes, which results in the loss of habitats for plants and animals adapted to the dune habitats. We have a poor understanding of the role of alternative disturbances in maintaining the various dune systems in Alberta, and research is necessary if we are to maintain these dynamic ecosystems. The following discussion paraphrased from the western spiderwort (*Tradescantia occidentalis*) *Status Report* summarizes the management apparent dilemma in trying to manage sand dunes in Alberta: "Historically, a combination of fire and grazing kept blowouts active. Dunes have been stabilizing in the Middle Sand Hills where there have been repeated fires but little grazing and in other areas where there has been grazing but few fires. The Pakowki Lake site is leased for grazing but the condition of remaining Mixed Grassland is deteriorating because of increased grazing. This presents a management dilemma. The positive or negative impacts of grazing at various times of the year are unknown. A current theory is that late summer or fall fires formerly created lush green areas the following spring. These green patches attracted large herds of grazing animals like bison and resulted in reactivation of the sand dunes. The sand hills also apparently were used as sheltering areas by bison during the winter and this could have been significant in keeping dunes active. Fire control and changes in grazing patterns have completely changed the factors that shape sand dune environments" (Smith 2000).

Threats to dune habitats include ATV use on the dunes, cattle grazing, sand removal, and dune stabilization. A number of rare plants and animals are associated with the dunes, and the ecology of these species is generally poorly known and understood. At risk species include the small-flowered sand verbena, *Dipodomys*, western spiderwort, and the Ord's kangaroo rat (*Dipodomys ordii*).

Western spiderwort occurs on dunes near Pakowki Lake in southern Alberta. All other sites that host western spiderwort in North America are infested with leafy spurge, but leafy spurge has not yet reached Alberta. Other exotic plants are thought to threaten dune plants in Alberta, but a systematic review is needed.

The small-flowered sand verbena (*Tripterocalyx micranthus*) is a small annual plant on COSEWIC's Schedule 2, occurring at multiple sandy sites in southeastern Alberta in the general area where the Bow, Oldman, and South Saskatchewan rivers come together (Smith & Bradley 1992) and at sites further downstream along the South Saskatchewan (Smith 2003). Again, dune stabilization is a major threat to the persistence of this rare plant. Little known about the ecology of the plant or its seed bank, germination, or dispersal. The role of climate, cattle grazing, and dune stabilization need to be better understood.

ACA is currently funding a project entitled "Landscape change in the Middle Sand Hills: implications for endangered kangaroo rats (*Dipodomys ordii*) and other species that depend on sandy habitats" by David Gummer of the Alberta Provincial Museum. The study is being conducted at Canadian Forces Base Suffield in partnership with the Department of National Defence. Kangaroo rats are found in sand dune habitats and hard-packed soils of arid grasslands in southeastern Alberta (Gummer 1997).

Athabasca Dunes Ecological Reserve, west of Richardson River on the south side of Lake Athabasca, is the largest dune field in Canada hosting 10 endemic rare plants. This area is sufficiently remote that human disturbance and management is not a perceived threat to this unique area. A monograph on the vegetation of the Athabasca Dunes of Alberta and Saskatchewan (Raup and Argus 1982), and a website describes the area: (http://collections.ic.gc.ca/abnature/boreal/featured_athabasca_dunes.htm). Another protected area includes the Brule sand dunes along the Athabasca River at Jasper National Park.

49. ►Suffield elk herd

This research need is similar to the Camp Wainwright elk study (rank #41). Again, issues relate to an expanding population of elk and increasing conflicts with farmers. Also, for this area there exist concerns regarding possible impacts of the proposed development of a dam on the South Saskatchewan River adjacent to Suffield.

50. ►Density dependence in moose populations

See discussion and references associated with the topic ranked #27 in the previous research needs list.

51. ►Low moose density in NW Alberta

See discussion and references associated with the topic ranked #44 in the previous research needs list.

52. ►Browse production for ungulates

Given the paradigm that habitats are the bottom line for wildlife management, and knowing that browse is the primary forage for moose, deer, and elk during winter, it follows that managers need to understand ecological factors and management tactics that influence browse production. Given the recent review of ACA's ungulate habitat management programs, research focused on cost-effective management to enhance browse production seems warranted.

53. ►Habitat models for Harlequin ducks

Recent status reviews of harlequin ducks in Alberta (Kneteman & Hubbs 2000, MacCallum 2001, Smith 2001a, 2001b) indicate a need for better understanding of ecological factors including hydrologic variables that determine the distribution and abundance of harlequins. Resource selection functions might be the appropriate tool for building such predictive models (Manly et al. 2002).

54. ►Review of provincial recovery plans.

A recent review of recovery plans prepared for the Endangered Species Act in the U.S. (Clark et al. 2002) stimulated considerable controversy about how to evaluate the effectiveness of such plans (Beier 2003, Clark et al. 2003, Leonard 2003). Some recovery plans appear to be paper exercises with little consequence for management. Other plans have been very successful resulting in proposals for delisting of endangered species. The composition of recovery teams in Alberta is determined by the Minister of Sustainable Resource Development, and economic interests have been well represented. A critical review of Alberta's recovery plans for species at risk, and an evaluation of the

government's responses to recovery plans may help future plans to be more effective.

55. ►Fisher ecology and management in the Rockies

Fishers are doing well in NE Alberta, but are relatively uncommon in the Rocky Mountains and foothills of western Alberta. We do not understand habitat factors influencing distribution and abundance and we have insufficient information about possible threats to their continued persistence. Fishers are sensitive to trapping pressure, and reducing trapping mortality might be an important strategy. For example, perhaps marten trappers can use traps that are less likely to harvest fisher. Translocations have been used successfully to restore fisher populations in several areas of North America and might be warranted in portions of Alberta (Drew et al. 2003).

56. ►Effective enforcement for conservation

In view of recent SARA legislation, a critical review of regulatory regimens, policy, and enforcement program for conservation is needed. Some federal regulations and treaties are not being enforced or respected by the provinces. Managing local environmental resources with moderately enforced government regulations often can be counterproductive, whereas non-binding communications can be remarkably effective (Murphy and Cardenas 2004). Engaging First Nations in wildlife conservation programs can be critical to the implementation of conservation actions, especially in northern Alberta. Agency partnerships and public education programs may be necessary for wildlife enforcement programs to be effective as has been found for Canada's Fish Habitat Management program (Goodchild 2004). Jordan Walker (M.Sc. 2004) worked with Lee Foote and Alberta SRD Provincial Biologist Michael Sullivan to examine compliance among fishermen at 9 lakes in central Alberta, half of which

received enhanced (doubled) enforcement effort. Key enforcement principles became evident and ways to educate anglers as to how to aid fisheries recovery were advanced.

57. ►Hunter access issues in the white zone of Alberta.

Increasingly hunters complain that gaining access to private lands is difficult. Partly in response to this, the Hunting for Tomorrow Foundation is compiling maps of public access for hunting for Alberta's "white zone," which will be available on a website. To know how to develop programs to encourage landowners granting access for hunting on private lands, it would be useful to have a landowner attitude survey regarding hunters and what it would take to make more lands available for hunters.

58. ►Swainson's Hawk (*Buteo swainsoni*) and Ferruginous Hawk (*Buteo regalis*) population declines

The ferruginous hawk is listed as "at risk" in Alberta, having declined substantially in abundance during the past century. Ground squirrels make up approximately 90% of the diet of ferruginous hawks so conversion to cropland and intensification of agriculture has negatively affected this species. Likewise, declines in reproductive success of Swainson's hawks have been documented in Alberta (Houston & Schmutz 1995, Schmutz et al. 2001), associated with intensification of agriculture and reduced abundance of Richardson's ground squirrels. Swainson's hawks are more abundant than ferruginous hawks in Alberta, but still the species is designated as "sensitive" because of its declining status. Declines in both species were checked temporarily by a peak in vole (*Microtus pennsylvanicus*) abundance in the late 1990s (Poulin et al. 2001). Research to manipulate prey abundance, e.g., experimental protection of Richardson's ground squirrels might be attempted as a local remediation measure.

59. ►Pond aeration effects on wildlife

Shallow lakes can winter kill fish and other aquatic organisms when anoxic conditions develop under ice. To prevent winter kill, lake and pond aeration is practiced in many parts of Alberta. For example, 10 lakes near Carolyn are currently proposed for aeration. We are unaware of any evaluation of the wildlife consequences of such aeration. Open water might attract waterfowl and aeration may ensure more food for some species of wildlife. But there may be complex interactions if aeration attracts more anglers that displace wildlife.

60. ►Whooping crane nesting and predation study

Egg removals enhance recruitment at whooping crane nests in Wood Buffalo National Park (Boyce et al. 2004). The mechanisms by which this occurs are not

understood but an interaction with potential nest or chick predators is apparent. Parks Canada is reluctant to allow continued disturbance of nests despite benefits for conservation, partly because of uncertainty about the reasons for enhanced recruitment resulting from egg removals. Remote time-lapse cameras might provide a method to document the predators killing chicks or destroying nests.

61. ►Ecology and management of gray partridge (*Perdix perdix*) in Alberta

Although a popular game bird in agricultural areas, little scientific study has been conducted on the gray partridge in Alberta. Weeds are important for survival of gray partridge chicks in spring (Marshall et al. 2003). Cleaner farming methods, e.g., using genetically modified crops, reduce weed and insect abundance in agricultural areas, and can be expected to reduce recruitment (Southwood & Cross 2002). Sustainable agricultural and organic methods can be expected to provide better habitats for partridge and other birds.

62. ►Elk RSF on Milk River Ridge

A population of elk has established on the Milk River Ridge, in habitats quite different than anywhere else in Alberta. To understand key habitat components in this landscape and thereby be able to anticipate potential conflicts with agriculture, radiotelemetry of elk could permit the estimation of resource selection functions. Such habitat models should be constructed at a range of scales to permit application for a variety of management questions (Jones & Hudson 2002, Boyce et al. 2003).

63. ►Habitat selection by plains and wood bison (*Bos bison*)

Plains and wood bison are maintained in similar habitats, but in isolation at Elk Island National Park east of Edmonton. We would expect that habitat-selection preferences would be shaped by adaptation to different landscapes. This presents a unique opportunity to assess whether differences exist in habitat selection between the 2 subspecies (morphs?) that might have ramifications for proposed management of bison in Wood Buffalo National Park. Resource selection functions could be compared modelled at a range of scales of availability in each season (Larter & Gates 1991) within the confines of the park.

64. ►Ecology of long-tailed weasel

See discussion and references associated with the topic ranked #26 in the previous research needs list.

65. ►Peninsular security for waterfowl

A “peninsula effect” has been noted as a general biogeographic pattern, whereby species richness declines as distance from the based of the peninsula increases (Rapoport 1994). The mechanism for this pattern has been argued to relate to balancing dispersal and local extinction according to the island theory of biogeography (Wilson & Willis 1975). Alternatively, habitat diversity may be less on peninsulas, obviating the need to invoke island biogeographic theory (Means & Simberloff 1987). Andy Murphy (ACA, pers. comm.) has suggested that a peninsular effect might exist for nesting waterfowl where nesting on a peninsula offers security from nest predators because fewer predators are likely to explore the extent of a peninsula. Existence of such an effect might focus attention on habitat management for waterfowl on peninsulas of land in bodies of water. Alternatively, movements by some predators such as raccoons might actually be funneled along peninsulas creating the opposite effect.

66. ►Compensation in game bird harvest

See discussion and references associated with the topic ranked #41 in the previous research needs list.

67. ►The wild turkey as an exotic species in Alberta

See discussion and references associated with the topic ranked #39 in the previous research needs list.

68. ►Trumpeter swan (*Cygnus buccinator*) population expansion in Alberta

The trumpeter swan is the largest and rarest swan in the world, nearly extinct by 1918 when a small population was discovered near Grand Prairie, Alberta. The current population is still concentrated in the Grand Prairie area with additional nesting areas at Elk Island National Park and near Cardston and Pincher Creek. In 1996 COSEWIC de-listed the trumpeter swan from vulnerable to not-at-risk in Canada, although the species is still listed as vulnerable in Alberta. Recovery efforts have resulted in an expanding population and distribution (James 2000). Opportunity exists to better understand the spread of the species by modeling the diffusion process in a heterogeneous landscape or using integrodifference equations (Neubert et al. 2000). Also, behavioural ecology studies might help us to understand how to acclimate swans to human disturbance in nesting areas. Some swan pairs appear to be highly sensitive to disturbance whereas others are more tolerant of humans. Habitat attributes of ponds used by trumpeter swans during spring

migration has been studied by LaMontagne et al. (2003). ACA provides funding for the Trumpeter Swan Habitat Stewardship Project coordinated by Reg Arbuckle, Ducks Unlimited. The Alberta SRD, ACA and ACCRU supported work on the Alberta Trumpeter Swan Recovery Plan is underway overseen by SRD biologist Mark Heckbert of Grande Prairie.

69. ►Seasonal mortality of white-tailed deer near Edmonton.

See discussion and references associated with the topic ranked #46 in the previous research needs list.

70. ►Ecology and management of blue grouse (*Dendragapus obscurus*)

Blue grouse occur in the foothills and mountains of western Alberta from the Smoky River to the Montana border. Population attributes of blue grouse in SW Alberta were described by Boag (1966): breeding home ranges of 15 marked females averaged 17.4 ha, whereas territories averaged 0.6 ha. Greatest research needs for this species relate to habitat ecology and response to alternative forest management practices. The species usually fares well in 2nd growth forest stands after logging, but can be sensitive to heavy livestock grazing of brood habitats (Zwickel et al. 1968, Zwickel 1972a,1972b).

71. ►Trophy management for mule deer

Nutrition and age are primary factors determining antler size variation in deer (Strickland & Demarais 2000). Heritability for antler size in captive deer is fairly high (Williams et al. 1994), suggesting that selection for large antlers should result in a genetic response for smaller antler size. Yet, environmental variables have a large effect on nutrition and antler size variation in wild populations (Azorit et al. 2002, Kruuk et al. 2002), effectively reducing heritability and expected response to selection. Trophy deer management in SE Alberta (e.g., WMU 102) is done by restricting the harvest to low levels increasing the number of bucks that grow to maturity. This also reduces the selective pressure should there be any influence of selection against males with genetically larger antler size. Yet, a number of alternative harvesting strategies have been advocated for trophy deer management such as those promoted by the Quality Deer Management program (www.qdma.com). Experimental application of alternative harvesting strategies would permit an evaluation of recreational opportunities for deer hunters (see Woods et al. 1996).

72. ►Sharp-tailed grouse in the Peace River area

Recent research on sharp-tailed grouse habitats in east central Alberta offers a number of useful management recommendations (Manzer 2004). However, these may not apply in the Peace River area where we find a different mix of

crops and agricultural practices (Moyles 1981). During the past 20 years sharp-tailed grouse lek counts have declined markedly in the Peace River area, and much of this decline is likely attributable to changing land-use practices. A study of habitat ecology is what is needed, with a focus on evaluating management strategies to increase grouse populations in the Peace Parklands. Spatial distribution of habitats appears crucial, especially in the highly fragmented habitats of the Peace country (Akcakaya et al. 2004). This project should interface productively with ACA's initiative the "Peace Parkland Native Grasslands Stewardship Project."

73. ►Ecology and management of spruce grouse in Alberta

There is a long list of research topics needing attention for spruce grouse in Alberta. Food habits of spruce grouse have been studied in central Alberta (Perderga & Boag 1970, 1971), and population cycles have been recently reported for spruce grouse in the Yukon (Krebs et al. 2002). The range of the species appears to have been reduced at the southern fringe, largely by agricultural development. Forest management that keeps at least part of the landscape in early successional stages benefits spruce grouse populations (Boag & Schroeder 1992), and they do especially well in post-fire successional stands (Boag & Schroeder 1987). Population estimation techniques need to be developed and evaluated; Ratti et al. (1984) suggested that censusing activity trees might be more efficient that attempting to count the birds themselves (Schroeder & Boag 1989, Keppie 1992) but the method has not been evaluated. We do not know which silvicultural practices are most effective for spruce grouse in Alberta, including stand size, juxtaposition, or post-harvest treatments (r5gomp.fws.gov/gom/habitatstudy/metadata2/spruce_grouse_model.htm). Finally, we have little information on the consequences of hunter harvest on spruce grouse populations (Boag et al. 1979, Ellison 1991).

74. ►Assessment of road mortality on snakes

Road kill is one of the most significant limiting factors for both the rare hog-nosed snake (*Heterodon nasicus*) and the prairie rattlesnake in Alberta (Watson & Russell 1997, Wright 1998). GIS is a useful tool for mapping road kills to identify places where road kills were most common and to identify places where management might be implemented such as drift fences and properly designed culverts (Yanes et al. 1995).

75. ►Moving snake hibernacula

Snake hibernacula are sometimes destroyed during industrial, agricultural or residential development. Apparently these hibernacula can be moved, although I

have been unable to find any peer-reviewed literature on methods. Guidelines for constructing hibernacula for snakes are described at the Canadian Wildlife Federation website: (www.wildaboutgardening.org/en/dig_dwell_den/section2/index.htm#l8).

76. ►Loggerhead shrike (*Lanius ludovicianus*) habitat requirements in Alberta

Loggerhead shrikes are endangered in eastern Canada, and threatened in Alberta. Shelterbelts, hedgerows, and abandoned farm sites are preferred habitats in Alberta (Prescott & Bjorge 1999). Loss of habitats appears to be the principal cause for the decline of this species in Alberta (Telfer 1992). Habitat studies have been conducted on shrikes in Ontario and Quebec (Chabot et al. 2001); and in Kansas (Lauver and Busby 2002) where GIS models have been found to have good predictive capability. Development of an RSF model (Manly et al. 2002) would facilitate management for this threatened species in Alberta. Relevant data for estimation of such a model have been collected (Prescott & Collister 1993).

77. ►Population dynamics of herons and pelicans in Alberta

Few data are available on the demography and population dynamics of waterbirds such as herons and pelicans (Cezilly 1997), especially in Alberta. The black-crowned night heron (*Nycticorax nycticorax***)**, great blue heron (*Ardea herodias*), American bittern (*Botaurus lentiginosus*), white-faced ibis (*Plegadis chihi*), and American white pelican (*Pelecanus erythrorhyncos*) are all listed as sensitive species in the province. The distribution, natural history, and food habitats of black-crowned night herons in southern Alberta were described over 30 years ago (Wolford and Boag 1971a, 1971b), and the population appears to have increased during the past 20 years. Great blue herons were also surveyed over 30 years ago (Vermeer 1969), and currently the entire population in Alberta is sustained by fewer than 100 nesting colonies (http://www3.gov.ab.ca/srd/fw/status/1996/yellowb.html#Birds). Census of pelicans in northern Alberta was reported by Beaver & Lewin (1981), and currently only about 1,000 nesting pairs reside in the province.

A common requirement for these waterbirds is the availability of sites where they are undisturbed during the nesting period. Heronries have been abandoned due to disturbance in the form of housing and industrial developments (Simpson and Kelsall 1979). Colony protection for pelicans likewise is essential for their persistence.

78a. ►Shorebirds in the prairie pothole region

Although well known as being a “duck factory,” the prairie pothole region of central Alberta also is important for a diversity of shorebirds. Inventory of shorebirds should be compiled, and alternatives for management should be evaluated. In view of recent droughts in the region, consideration of the ramifications of predicted climate change would appear useful. ACA’s Grant-Eligible Conservation Fund has supported the Canadian Wildlife Service on 2 relevant projects: “Identification of Priority Areas for Breeding Shorebirds and Marshbirds within the Grassland and Parkland of Alberta,” and “Identifying Species-Habitat Linkages for Priority Landbirds, Shorebirds, and Species at Risk in Alberta's Grasslands.” Shorebirds were monitored as part of the pilot Alberta Marsh Monitoring Program (Priestley 2002).

78b. ►Sora (*Porzana carolina*) population dynamics

Sora populations have declined as a consequence of the loss of wetlands across North America, but the species is still abundant and is legally hunted as a migratory game bird. Sora were monitored during the pilot of the Alberta Marsh Monitoring Program sponsored by Bird Studies Canada (Priestley 2002). A comprehensive review of the effect of marsh management practices on sora is available on the web (Zimmerman et al. 2003). Protection of wetlands is probably the most important issue for maintaining sora populations. Of 49 nests found in Alberta, 39 were in areas dominated by sedges, three in cattail, three in spikerush (*Eleocharis* sp.), two in tall mannagrass (*Glyceria grandis*), one in rush (*Juncus* sp.), and one in marsh smartweed (*Polygonum amphibium*)(Lowther 1977). Call response surveys can be used to document trend in abundance (Gibbs & Melvin 1977).

Table 1. List of wildlife research needs in Alberta, ranked according to the SMART process (Ralls and Starfield 1994), modified slightly since the last research priorities review (Boyce 2000).

Project	Rank	Score
Climate change & conservation	1	11.017
Caribou/wolf/moose & deer	2	10.646
Access management experiments	3	10.502
Landscapes & grizzlies	4	10.202
Waterfowl nest predation	5	10.194
Elk range & livestock grazing	6a	9.27
Bighorn sheep conflicts with cattle	6b	9.27
Restoration of habitats for wildlife	7	9.011
Vital rates mapping	8	8.920
Grazing-lease mgt for wildlife	9	8.915
Hydrology and beavers	10	8.755
Feral horse conflicts with wildlife	11	8.654
Grazing effects experiments	12	8.4
Wildlife habitats on private lands	12	8.4
White-winged scoters	13a	8.21
Mountain pine beetle/caribou	13b	8.21
Bighorn life-history & mines	14	8.172
Timothy expansion on elk winter range	15	8.142
Boreal grizzly bear	16	8.059
Evaluate HSP program for SAR	17	8.041
Habitat for ecosystem mgt	18	7.906
Fragmentation w/game fences	19	7.894
Otter harvest study	20	7.638
Grazing in parklands	21	7.531
Overwintering waterfowl	22	7.519
Invasive plants and wildlife	23	7.42
Timing of disturb on winter ranges	24	7.379
Economics of SARA	25	7.341
Modeling of SARA funds	26	7.34
Wolves in SW Alberta	27	7.292
Molecular genetics of deer	28	7.232
Ruffed grouse population cycles	29	7.038
Selenium in wildlife re: mining	30	6.941
Goat hunt in Alberta/habitat	31	6.932

Aversive conditioning grizzlies	32	6.743
Peace-Athabasca Delta	33	6.731
Ecology of mosquito control	34	6.704
Aerial survey for deer	35	6.696
Public attitudes re CWD	36	6.51
Risk assessment re: CWD	37	6.464
Evaluation of breeding bird survey	38	6.409
Swift fox mortalities	39	6.19
Aerial survey alternatives	40	6.173
Wainwright elk herd	41	6.169
Elk depredation studies NW Alta	42	6.126
White-tailed deer harvest	43	6.02
Urban deer mgt	44	5.996
Road-killed deer	45	5.827
Keystone species	46	5.801
Peripheral populations	47	5.768
Sand dune species	48	5.729
Suffield elk herd	49	5.662
Density dependence in moose pop	50	5.603
Low moose density in NW Alberta	51	5.557
Browse production	52	5.493
RSF models for Harlequin	53	5.493
Review of recovery plans	54	5.467
Fisher in the Rockies	55	5.326
Enforcement program review	56	5.186
Hunter access issues	57	4.84
Swainson's Hawk declines	58	4.831
Wildlife associated aerated ponds	59	4.793
Whooping crane nesting	60	4.763
Hungarian partridge	61	4.261
Elk RSF on Milk River Ridge	62	4.16
Habitats of bison subspp	63	4.093
Ecology of long-tailed weasel	64	4.084
Peninsula effects--waterfowl	65	4.046
Compensation in game bird harvest	66	3.907
Turkeys--negative effects?	67	3.814
Trumpeter Swans	68	3.607
W-Tdeer mortality nr Edmonton	69	3.292
Blue grouse ecology in Alberta	70	3.291
Trophy mgt for mule deer	71	3.038
Sharp-tailed grouse in Peace	72	3.008
Spruce grouse	73	2.755

Road mortality on snakes	74	2.515
Garter snake hibernacula	75	2.477
Loggerhead shrike	76	2.354
Waterbird population dynamics	77	1.616
Shorebird diversity & distribution	78	1.485
Sora rail population dynamics	78	1.485

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