

NEW TECHNOLOGY FOR MOOSE MANAGEMENT: A WORKSHOP¹

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ABSTRACT: This paper provides outlines of presentations made during a special session devoted to new technology for moose management at the 4th International Moose Symposium and 33rd North American Moose Conference and Workshop, Fairbanks, Alaska, May 17 - 23, 1997. The intent of this session was to provide an overview of emergent technology that may benefit moose management and to suggest future directions for research. Advancements in the use of Global Positioning System technology for tracking moose and other wildlife were outlined. The performance of these new systems under both controlled and field situations were discussed. Recent progress in the application of ultrasonography to the assessment of moose nutritional and reproductive condition was presented. Prospects for the application of new genetic techniques, particularly molecular genetic markers, to the understanding and management of moose populations were considered. A new spatially based decision support tool for landscape level resource management was outlined and demonstrated. This special session highlighted the wide variety of new technologies that may have significant impacts on moose management in the near future and into the 21st century.

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Science progresses through new ideas and new ways of doing things. Wildlife biologists cannot escape the development of new techniques and their application to basic research and resource management. Sometimes a technique is deliberately developed to solve a particular problem, but other times chance and circumstance are responsible. A new way of doing things may simply involve the application of old ideas to a different situation or it may truly entail the use of the latest technology. In some cases wildlife biologists have found

ways to apply methods developed in other disciplines to their own areas of interest. Likewise, some of the techniques developed by wildlife biologists have contributed to other branches of science. Whether a method is innovative or tried-and-true, the intent is to gain new knowledge and improve the efficiency of resource management.

Given the potential significance of recent advances in methods of studying moose and other wildlife, a special session devoted to new technology was held at the 4th International Moose Symposium and 33rd

¹Order of authorship determined by the sequence of presentations at the 4th International Moose Symposium and 33rd North American Moose Conference and Workshop, Fairbanks, Alaska, May 17 - 23, 1997.

North American Moose Conference and Workshop, Fairbanks, Alaska, May 17 - 23, 1997. The primary objective of this workshop was to highlight and update emerging technologies that may have significant impacts on moose management in the near future and into the 21st century. This was a highly varied session. Topics included updates on development and performance of telemetry systems using Global Positioning System (GPS) technology, new DNA and other genetic methods, new uses of ultrasonography in wildlife biology, and the role of decision support systems in moose management and wildlife conservation. Although some data from recent studies were presented to exemplify new technology or provide demonstrations, the session was intended to be educational rather than results oriented. Outlines of conference presentations covering these topics are provided in the following sections. The author responsible for each presentation is identified at the beginning of each section and may be contacted directly for more information related to the particular topic.

Advancements in the use of GPS technology in obtaining position information from free-ranging wildlife - Stanley M. Tomkiewicz, Jr.

Telemetry used to track wildlife has advanced dramatically over the past two decades. While advancements occur continually in existing systems, only rarely does technology come along which radically revolutionizes the way in which we conduct wildlife tracking research. In the early 1980s the ARGOS system was such a development. By the close of the 1980s, projects on eagles, cranes, geese, and other wildlife applications were underway, and the technology had become an operational tool for tracking the long-range movements of animals. The ARGOS system will continue to expand through the end of the 1990s

and into the next century.

ARGOS is not the only satellite-based system revolutionizing wildlife research. The newest system to make its debut is the Global Positioning System (GPS). Unlike ARGOS, the subject animal carries a GPS receiver that receives data from satellites and calculates the position of the subject. GPS presents the potential for increased position accuracy to a level never before possible utilizing a satellite-based positioning system. GPS is based on the time of arrival of signals transmitted from the satellites to calculate the position of a receiver carried by the subject. The GPS receiver is pinpointed and, therefore, if the subject animal is carrying a GPS receiver, the animal is also positioned.

Multiple approaches for GPS data recovery have been implemented. First, it is possible to store the GPS positions on board the animal for later recovery. In this instance, the unit is physically recovered and the data are downloaded. The second approach is to relay the GPS information through direct transmission from a transmitter on the animal to a receiver carried by the biologist. Various modulation formats can be considered, including FM (frequency modulation), AM (amplitude modulation), and PM (phase modulation). The difficulty with this approach is range limitation.

A third alternative is the use of low polar-orbiting relay satellites to recover GPS information. The NOAA/ARGOS system is currently being used for this purpose, and represents a highly reliable way of recovering GPS positions from extremely remote locations without the need for having a receiver or biologist present to obtain the information. In this mode, the ARGOS system essentially becomes a data transfer system as opposed to a positioning system. In addition, the biologist can carry an uplink receiver and intercept the signal transmitted by the ARGOS transmitter on board the

animal and recover and process the data directly.

Development of all these technologies is proceeding, driven by the need to answer new questions posed by the wildlife community. This paper described some of the advances in the technology associated with utilizing GPS to track free-ranging wildlife.

Performance of GPS collars on moose: an update - Arthur R. Rodgers and Elise J. Lawson

Sixty moose have been fitted with Lotek GPS collars since February 1995 in north-western Ontario (Rodgers *et al.* 1995, 1996). Presently, the collars are programmed to attempt a fix every 4 hours on 6 days of the week and every hour on the 7th day. A total of 60 locations are attempted per collar per week: over 3,500 for all 60 collars every week. From February 1995 to December 1996 there were close to 350,000 fix attempts. Data stored by each unit include raw pseudo-ranges, date and time of each fix attempt, GPS fix type (i.e., 2-dimensional or 3-dimensional), associated horizontal dilution of precision (DOP) and convergence, as well as sensor information (i.e., activity and ambient temperature). In 1995 the median operating life of the collars was 282 days (range = 36 - 322 days). Following modifications, the median operating life of the collars in 1996 increased to 321 days (range = 119 - 355 days). The proportion of successful observations (i.e., the proportion of fix attempts in which signals were received from ≥ 3 satellites) was higher in 1995 (68.6%) than 1996 (62.8%). Observation rates in both years are similar to those measured previously (66.1%) under controlled forest conditions (Rempel *et al.* 1995). On a seasonal basis, successful observations were obtained most often in late-winter-early-spring (73.9% in 1995; 73.8% in 1996) and least often in late-spring-summer (60.9% in 1995; 50.1% in

1996). In both years the proportion of successful observations was slightly higher in the fall-early-winter period (64.4% in 1995; 54.3% in 1996) than in late-spring-summer. Seasonal variations in observation rates reflect general shifts in patterns of habitat use related to changes in moose life history requirements for food and cover. Differences between years are more likely due to climatic variation. Although future modifications to GPS collars may extend their operating life, little can be done to improve observation rates mediated by biological and environmental factors beyond the control of researchers. In spite of these limitations, GPS-based telemetry systems have the advantage of providing a significantly larger number of animal locations with much greater accuracy than either conventional VHF telemetry or other satellite-based systems.

Application of ultrasonography in assessing nutritional condition and reproduction - Thomas R. Stephenson

Assessment of nutritional condition and reproductive performance provides insight into population productivity. Ultrasonography enables prediction of body condition and examination of various reproductive parameters in live animals. Regression equations exist to accurately and precisely predict total body fat and body mass in moose from measurement of subcutaneous rump fat. Ultrasonography has been used to successfully determine *in utero* pregnancy and twinning in moose during both early and late gestation. In addition to permitting scanning of the presence and number of *concepta*, ultrasound may be used to evaluate ovarian structures (e.g., follicles and *corpora lutea*). Utility of transabdominal and transrectal scanning varies with animal size and structures of interest. B-mode (brightness mode) real-time ultrasound generates two-dimensional

images whose brightness is proportional to the amplitude of returning echoes emitted from piezoelectric crystals located in the transducer. Image resolution declines, while scanning depth increases as transducer frequency decreases from 7.5 MHz to 3.0 MHz. Electronic callipers permit accurate measurement of tissue layers and anatomical structures. The application of ultrasonography to wildlife biology remains in its infancy and its utility will broaden as the technology continues to improve.

Genetic techniques and their application to moose management - Kris J. Hundertmark

Analysis of genetic variation can entail the study of phenotype or genotype. The study of phenotype is confounded by gene and environmental interactions but is essential when studying heritability or fitness correlates. Numerous techniques exist for analysis of genotype. Allozymes are allelic enzymes (gene products) that can be resolved on a gel and represent one of the oldest techniques available. Analyses of allozymes have been used to examine population subdivision, systematics, and the relationship between genetic diversity and fitness correlates. Allozymes are relatively inexpensive to analyze; however, obtaining enough loci for analysis requires tissues that can only be collected from dead animals. The advent of the polymerase chain reaction and sequencing technology has allowed intensive genetic analyses to be conducted on extremely small tissue samples, and has permitted analysis at the nucleotide level in both nuclear and mitochondrial genomes. Mitochondrial DNA (mtDNA) is a maternally inherited genome that is useful for determining phylogenies on time scales ranging from recent to millions of years before present. The high degree of female philopatry characteristic of moose (*Alces alces*) and numerous other wildlife

species make mtDNA particularly useful for determining population identity on a broad spatial scale.

Application of molecular genetic markers to the understanding and management of moose (*Alces alces*) populations - Paul J. Wilson and Bradley N. White

Molecular genetic protocols have many important applications in addressing wildlife management issues. We have applied DNA technology to specific questions involving moose (*Alces alces*) with emphasis on Ontario populations in comparison to other Canadian populations. In a general sense, the four main objectives we apply to studies of moose and other wildlife and marine mammal species include: (1) identifying genetically distinct populations to recommend the appropriate management units; (2) examining the levels of genetic diversity within populations to identify potential high risk populations that may demonstrate the detrimental effects of inbreeding; (3) the identification of sub-species range and the determination of hybridization; and (4) the use of DNA markers and data bases to wildlife forensic science. I discussed the specific DNA markers we utilize in addressing the above objectives, and explained the level of information that can be obtained. The specific marker systems include multilocus DNA fingerprinting, microsatellite analysis, gender identification using a Y-chromosome-specific marker, and cloning and DNA sequencing of the immune genes in the Major Histocompatibility Complex (MHC). Multilocus DNA fingerprinting was the original DNA marker that was used to assess overall genetic variability in moose and identified low levels of genetic variability when compared to other species, including white-tailed deer (*Odocoileus virginianus*) (Guglich *et al.* 1993). Genetic variability can now be further assessed using microsatellite DNA

markers and the functional MHC locus (Mikko and Andersson 1995). Microsatellite analysis will also provide information on the population structuring of moose from different geographic regions. The relationship among these DNA markers is under investigation and whether these markers correspond with each other with respect to genetic variability is presently being analyzed (Wilson *et al.*, *unpubl.*). The issue of neutral versus functional DNA markers, and the information they provide, is an important one. Gender identification of moose samples (Wilson and White, *in press*), including hair and scats, is a potentially important application to assess sex ratios within moose populations. The direction conservation genetics is moving was also discussed, with emphasis on new applications to reproductive studies in wildlife such as detecting fetal cells and twinning from maternal blood samples and several genes potentially involved in reproduction (e.g., insulin growth-like factor 1). Finally, the collaborative efforts of ecologists and geneticists were introduced in an attempt to stimulate discussion on the methodology of comparing the two different types of data to ultimately provide the most effective management strategies.

Resource planning and analysis in the year 2000 - Robert S. Rempel

Information demands of wildlife biologists are changing. For example, questions relating to criteria and indicators of sustainable forest management, ecological land-use planning, and adaptive ecosystem management will require quantitative, multi-dimensional analysis of fish and wildlife resources projected across space and through time. Forest wildlife biologists in the next millennium will contribute to the design of forested landscapes that meet the needs of multiple species and human values, and traditional focus on specific habitat for

a single featured-species will seldom occur. Because endemic plants and animals have adapted to the pattern and rhythm of natural disturbance, landscape patterns created through natural processes of disturbance will serve as an important model to design landscapes through timber harvest. In recent research with my colleagues (Rempel *et al.* 1997), we compared landscapes created through wildfire with landscapes created through dispersed block-cuts and traditional progressive clear-cuts. We found moose density to be highest in the wildfire landscape and higher than in the landscape harvested according to Ontario's moose habitat guidelines. These results suggest that a landscape based, ecosystem approach to wildlife management need not be in conflict with moose habitat management.

Spatially-based decision support tools will be essential for landscape planners as they attempt to emulate patterns of natural disturbance in the development of forest management plans, and then monitor outcome over time. In this presentation I described NDAPT (Natural Disturbance Analysis and Planning Tool), a GIS-based planning tool, that can assist planners in assigning cut-block layouts to emulate natural disturbance. NDAPT includes a GIS database of some 1,500 fires mapped at coarse scale, and 42 historical fires mapped at fine scale (residual patches > 0.25 ha). For broad scale planning, tools are included to explore patterns of the regional fire regime, and for fine scale spatial analysis, tools are provided for single and multiple patch analysis, including edge/area ratio, normalized area square, fractal dimension, and mean patch edge.

Logging is a mechanical disturbance, whereas fire is a chemical disturbance. Hence, we can never use logging to completely mimic the effects of wildfire. Nonetheless, by studying natural systems and emulating their properties we can learn to

do a better job managing our forests and protecting forest wildlife.

SUMMARY

Like other scientists, wildlife biologists strive to develop new methods and apply recent technological developments to the management of natural resources. The presentations made during this special session typify the diversity of new technology available to wildlife researchers. They are a testament to the imagination and courage of wildlife scientists to create or adapt new ideas and try them out. There is no doubt that these new methods will make important contributions to moose management into the 21st century.

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