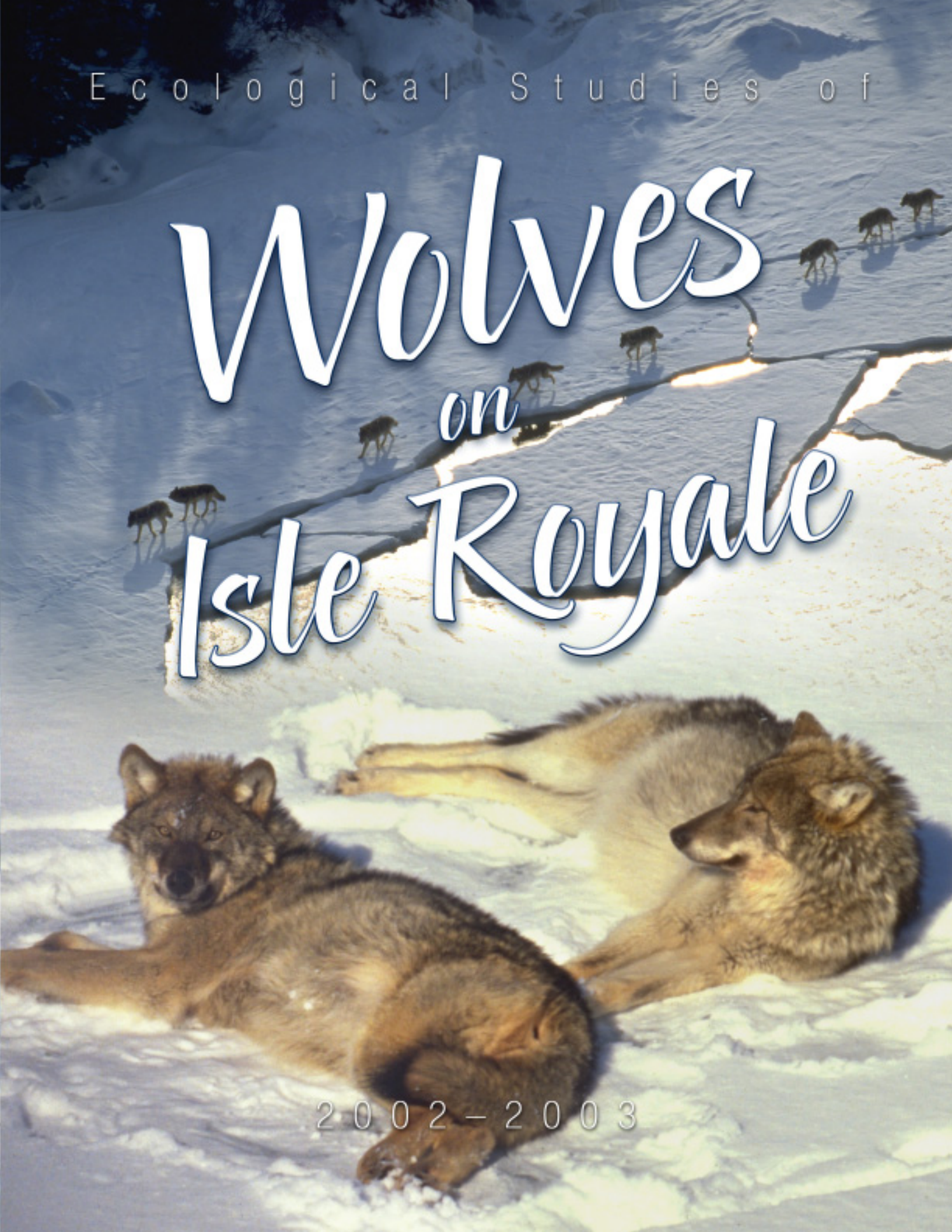
Ecological Studies of

Wolves on Isle Royale



2002–2003


"It is not enough
to understand the natural world;
the point is
to defend and preserve it."
Edward Abbey

Ecological Studies of Wolves on Isle Royale

Annual Report 2002-2003*

by
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31 March 2003

*During the past year, major support for these studies was received from the National Park Service (Co-op Agreement No. CA-6310-9-8001), National Science Foundation (DEB-9903671), Earthwatch, Inc., and the Robert Bateman endowment at the Michigan Tech Fund.

Additional contributions were received from the following organizations and individuals: Randall F. Absolon, Lillian M. Baklarz, Dorthey L. Behrend, Greg Capito, Alison J. Clarke, James E. Deignan, Ronald D. Eckoff, Edith N. Greene, Edward O. Haelterman, Tim Heitter, Frances R. LeClair, Brian E. McLaren, Michael W. and Kari Palmer, Janet L. Parker, Rolf and Carolyn Peterson, Ruth S. J. Peterson, Tony Peterle, Darcy R. and Robert Rutkowski, Loyd G. Schemenauer, Billie E. Smith, and Dorothy D. Zeller.. At Michigan Tech, William A. Tembruell and Diane Keranen of University Relations were instrumental in producing this report. Unless otherwise noted, all photographs are by Rolf O. Peterson.

Important contributions and personal time and financial assistance from the following Earthwatch volunteers are gratefully acknowledged:

Team 1: Ron Eckoff, Don Gossett, and leader Greg Wright.

Team 2A: Valerie Anderson, Jeffrey Holden, Amy Staffen, Rich Staffen, and leader Philip DeWitt.

Team 2B: Rachel Shulman, Christine Spencer, Josh Stein, and leader Ken Mills.

Team 3A: Vanessa Gates, Nathan Hambel, and leader Philip DeWitt.

Team 3B: William Bowen, Andrea Caires, Kung-Chong (K.C.) Quan, and leader Tim Pacey.

Tax-deductible donations to support continuing research on Isle Royale wolves and moose can be sent to Wolf-Moose Study, Michigan Tech Fund, Michigan Technological University, 1400 Townsend Drive, Houghton, Michigan 49931-1295. THANK YOU to all who help!

Results reported here are preliminary and, in some cases, represent findings of collaborators; please do not cite without consulting the authors.

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Ecological Studies of Wolves on Isle Royale

"The human mind is a product of the Pleistocene age, shaped by wildness that has all but disappeared. If we complete the destruction of nature, we will have succeeded in cutting ourselves off from the source of sanity itself."

—David Orr, 2002, *Adbusters*

Personnel and Logistics

In summer 2002, Rolf Peterson directed ground-based field work, aided by Philip DeWitt, Ken J. Mills, Tim Pacey, Erin Parker, Carolyn Peterson, John A. Vucetich, Leah M. Vucetich, and Greg Wright. Fieldwork continued from April 30 through August. In 2003 the annual winter study extended from January 9 to February 26. Peterson and pilot Don E. Glaser participated in the entire study, assisted in the field by Keren Tischler, John A.Vucetich, and Leah M.Vucetich, and the following personnel from Isle Royale National Park: Andy Bilton, Larry Kangas, Chris Lawler, Ann Mayo, Bill Munsey, and Mark C. Romanski. During the winter study, U.S. Forest Service pilots Wayne Erickson, Dean Lee, and Pat Lowe safely flew several supply flights to Isle Royale from Minnesota.

Summary

During 2002-2003, the wolf population increased slightly, from 17 to 19 individuals, while the moose population decreased slightly, from about 1,100 to 900 (fig. 1), reflecting relative stability over the past three years. Three reproducing packs continued to occupy territories similar to those of 2002, although there was considerable turnover and poor reproduction in the East Pack, as its territory shrank in the face of challenge from the adjacent Chippewa Harbor Pack. An estimated seven pups survived in three litters, so five (29 percent) of the 17 wolves present in 2002 perished, a mortality rate slightly above average. The moose population is currently very young, and wolf food supply (especially moose over 10 years old) will not increase until approximately 2007. In spite of shallow snow depths and few calves and old moose in the prey population, wolves were able to maintain midwinter kill rates at or above average levels.

Moose have been slowly increasing since 1996, when most of the population died of starvation. In the past year, this sustained increase was halted as an outbreak of winter ticks led to higher moose mortality last spring, followed by reduced recruitment in the 2002 cohort. The tick outbreak coincided with a continent-wide moose mortality event that extended from New Hampshire to Alberta, perhaps resulting from an unusually warm autumn in 2001. Another contributing factor was a late and cold spring in 2002. During winter 2002-2003, there were record-low snow depths, air temperature was unusually low, and wind speed was above average.

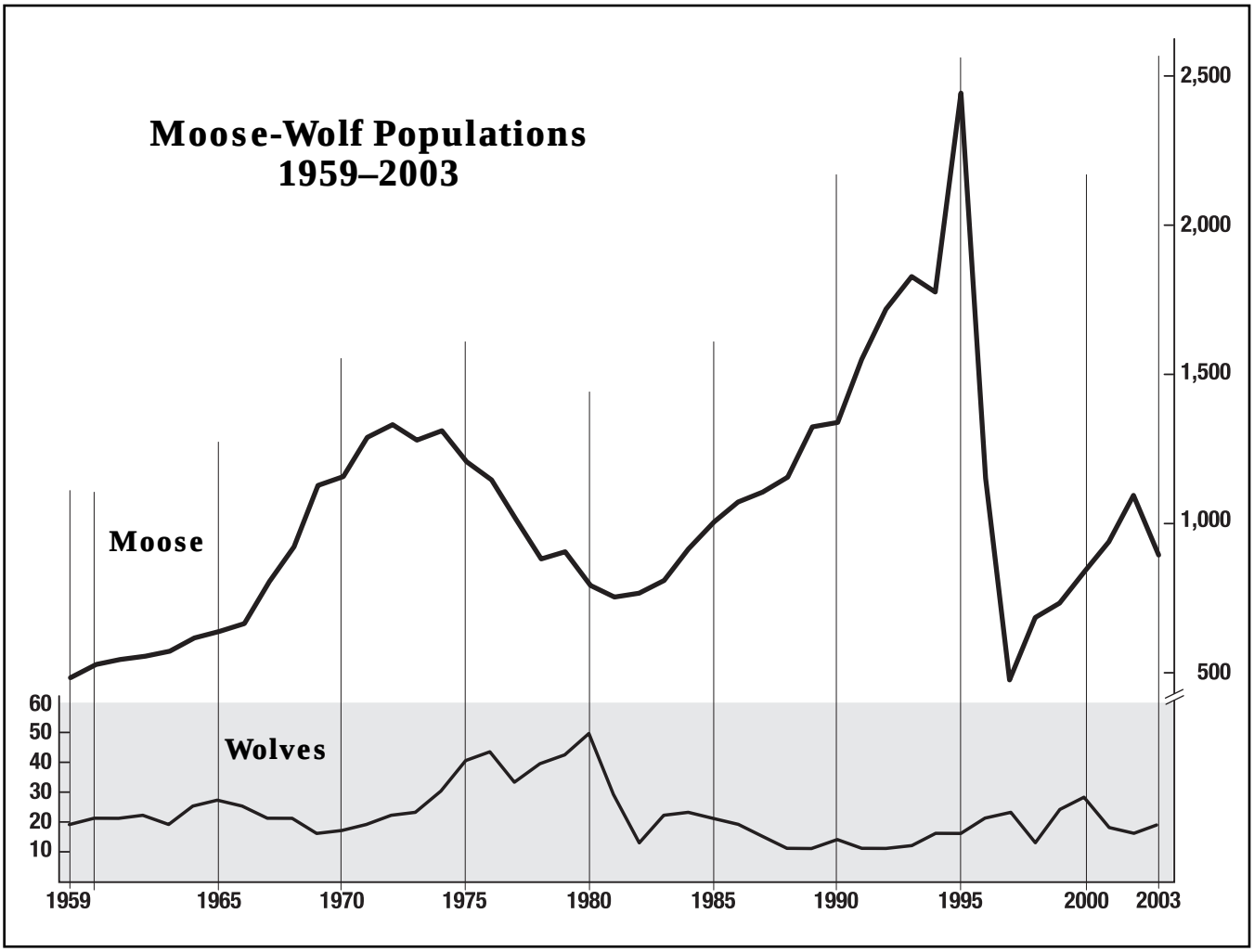


Figure 1. Wolf and moose fluctuations, Isle Royale National Park, 1959-2003. Moose population estimates during 1959-1993 were based on population reconstruction from recoveries of dead moose, whereas estimates from 1994-2003 were based on aerial surveys.

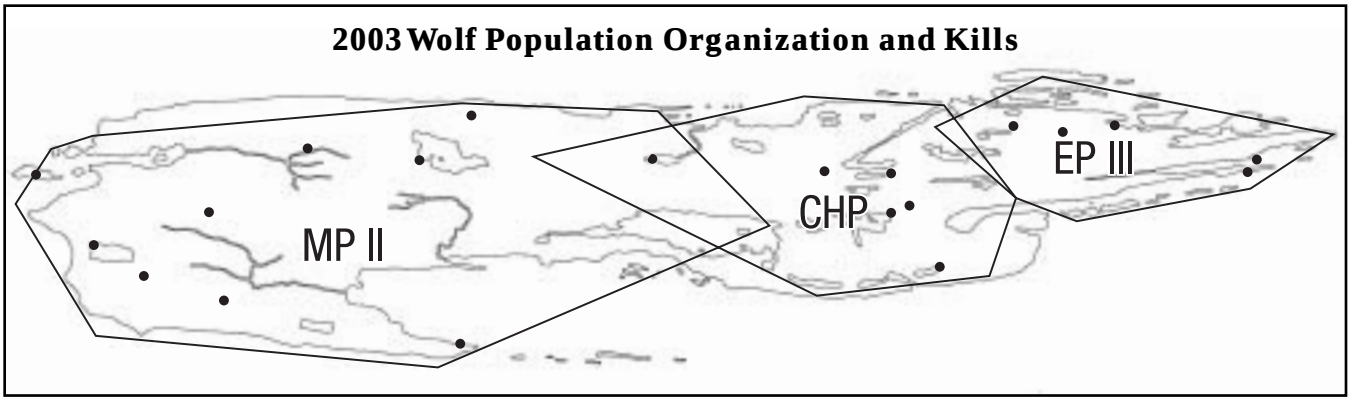


Figure 2. Wolf pack movements and moose carcasses (all fresh wolf-kills) during the winter study in 2003. Scent-marking was observed by all three of the packs.

The Wolf Population

During the 2003 winter study, the wolf population contained three territorial packs (fig. 2) and a total of 19 individuals, a slight increase over the 17 recorded in 2002 and identical to the 2001 level. The apparent stability likely resulted from a relatively constant yet low food supply. The social organization of the wolf population changed little from last year:

East Pack III 3
Middle Pack II.....7
Chippewa Harbor Pack.....6
Singles.....3
Total 2003 19

Two wolves radio-collared in 2001 continued to transmit: male 670 (alpha male in East Pack) and

Figure 3. Alpha female in the East Pack stands near freshly-killed moose while alpha male (male 670) sleeps.

Figure 4. (Left) Alpha female, in front, and male patrol their Chippewa Harbor Pack territory, trailed by two pups (right). Pups in this pack were large and evidently well-fed early in their development.

female 1070 (alpha female in Middle Pack). Male 670 took advantage of the rapid loss of two successive alpha males in the East Pack in 2001-2002. By 2003, the East Pack lost at least five of the six members (including four pups) from 2002. By summer in 2002, the East Pack recruited male 670 as new alpha male about three months after he dispersed from the Middle Pack, and one pup born in 2002 survived to winter 2003. Some mortality in the East Pack has resulted from aggression by the adjacent Chippewa Harbor Pack, and during the 2003 winter study the East Pack wolves restricted most of their movements to the peninsulas at the extreme east end of the island. Here the pack seemed vigilant as its members fed on a series of three moose-kills made on open ice (fig. 3).

The Middle Pack and Chippewa Harbor Pack both increased on the strength of high survival and reproduction in 2002. Four pups survived in the Middle

Figure 5. Wolf interloper (3722) was killed by the resident Middle Pack near Windigo.

Figure 6. Wolf 3722 exhibited an unusual congenital anomaly—his middle toes on both front feet were fused (left). The bones of both feet were normal (right). This may be an example of "genetic load" in this highly inbred population.

Pack and at least two survived in Chippewa Harbor Pack (fig. 4). Courtship behavior was observed in all three packs, and it is anticipated that three litters of pups will be born in 2003.

While patrolling the borders of its territory in February, the Middle Pack, with seven wolves, encountered and killed a single wolf that had evidently dispersed from another pack (fig. 5). The victim was a 36-kg (80-lb) adult male in very good nutritional condition, with layers of subcutaneous fat present on its hindquarters. A minor genetic anomaly was evident in both its front feet (fig. 6), perhaps a reflection of the inbreeding and the loss of genetic variability that characterize this isolated wolf population. We expect that natural selection continues to purge genetic abnormalities that severely hamper survival, but "minor" genetic defects may persist and accumulate as generations pass.

In spite of little snow in 2003, all 3 wolf packs were able to maintain kill rates at or above long-term average levels (about 2 kills per 100 days per wolf). This winter, we recorded per-capita kill rates (per 100 days) of 4 for the East Pack, 3 for Middle Pack, and 2 for Chippewa Harbor Pack.

Overall, wolf mortality rate (29 percent) in the past year was high but was concentrated in the beleaguered East Pack (fig. 7). Pup production was high (38 percent of the wolves counted in 2003), boosting wolf numbers up from 2002. It is anticipated that wolf food supply will remain near current levels until old moose (which provide most prey biomass) begin to increase in 2007. These moose would correspond to those born in 1997, when the population began to rebuild after the 1996 die-off.

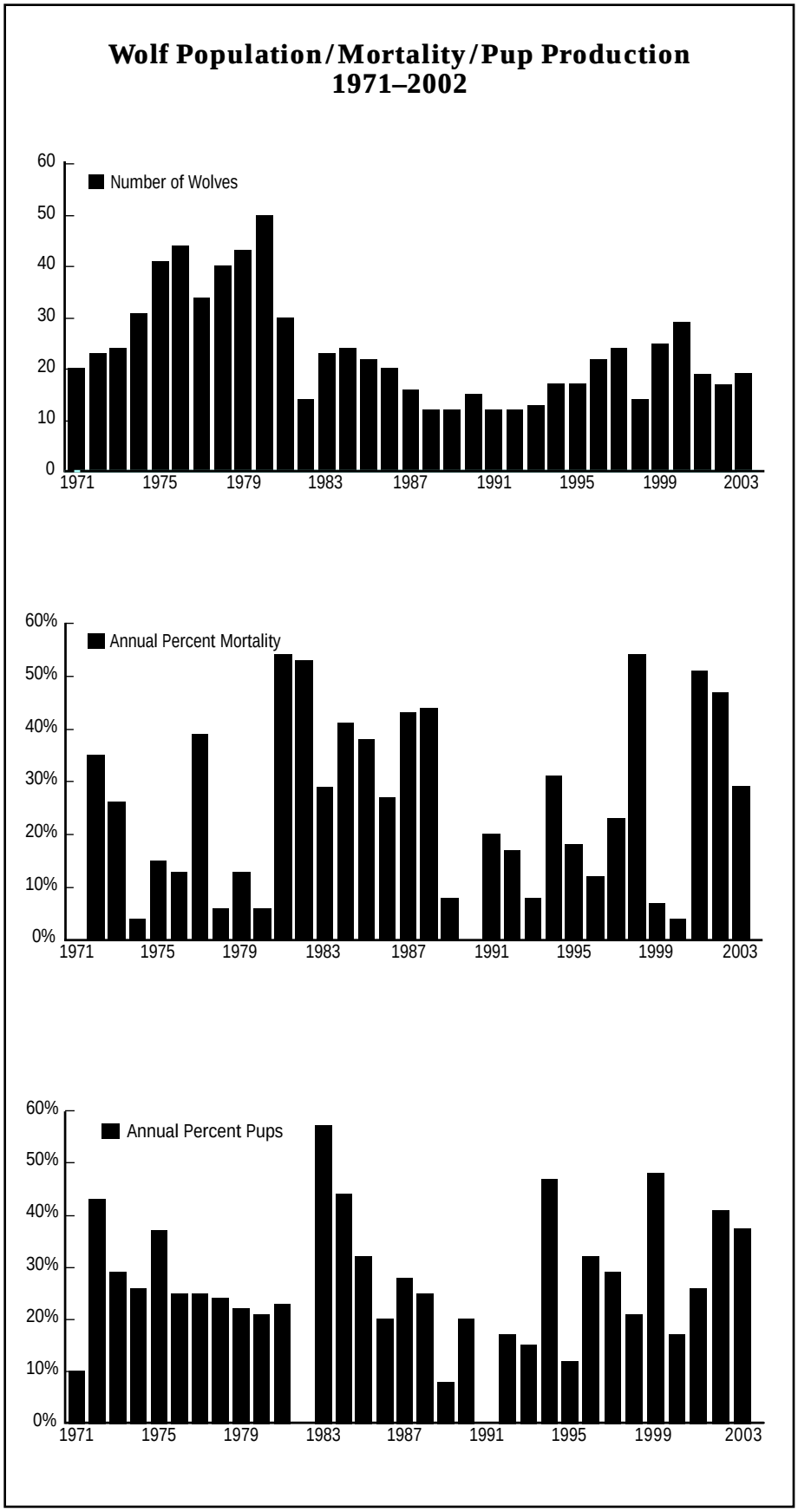


Figure 7. Wolf population size (top) is explained by patterns of mortality (middle) and reproduction (bottom).

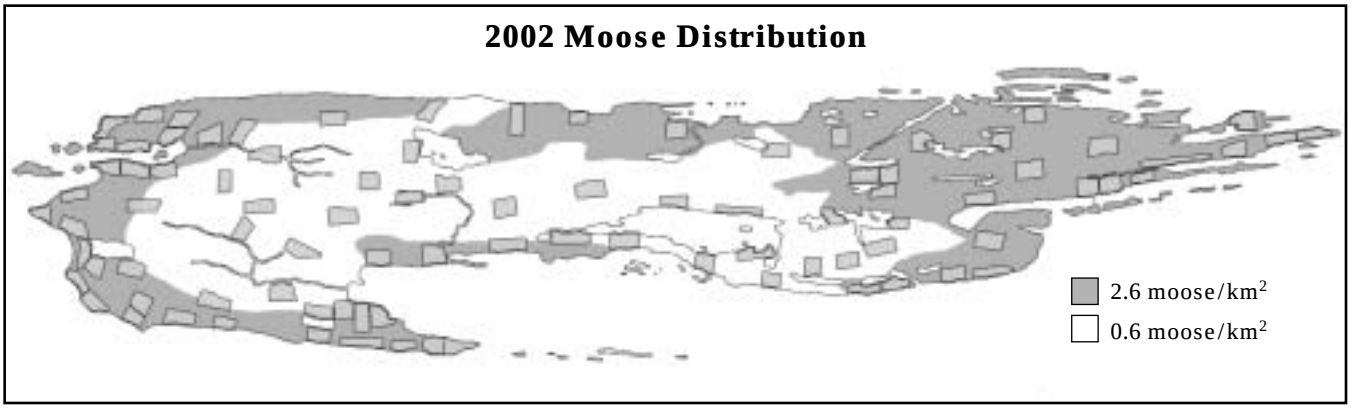


Figure 8. Moose distribution on Isle Royale was unusual during the aerial census in February 2003, as moose were unrestricted by snow. Only two strata were delineated. Also shown are the 91 plots where moose are counted from aircraft.

The Moose Population

During February 2003, the moose population was estimated at about 900 animals (+/- 95 percent confidence interval of 222), or 1.7 moose/km2 (fig. 8). This compares to an estimated 1,000 moose in 2002 and 900 in 2000. Calves constituted 8 percent of the 132 moose counted on census plots, considerably below the long-term average of 13 percent for Isle Royale moose (fig. 9). Only one set of twin calves was observed during winter 2003, another indication that calf abundance was relatively low.

The decline in the moose population in the past year can be attributed to the effect of winter ticks in late winter and spring, 2002. In spring and summer we found 12 carcasses of moose that succumbed to malnutrition, and all of them had considerable hair loss and evidence of tick infestation. The individual loads of ticks on moose were not as high as in some other years (notably 1989), but spring was late and most moose observed in May had dramatic loss of hair (fig. 10). During the spring of 2002, there was a synchronous loss of moose in many areas of North America (extending from New Hampshire to Alberta, Canada), and winter ticks were implicated in areas where reported losses were high. (See article by W. Samuel in *The Moose Call*, January 2003.) Other biologists reported that March and April were unusually cold and snowmelt was late, exacerbating the effect of ticks on moose. The synchronous nature of moose deaths across the middle

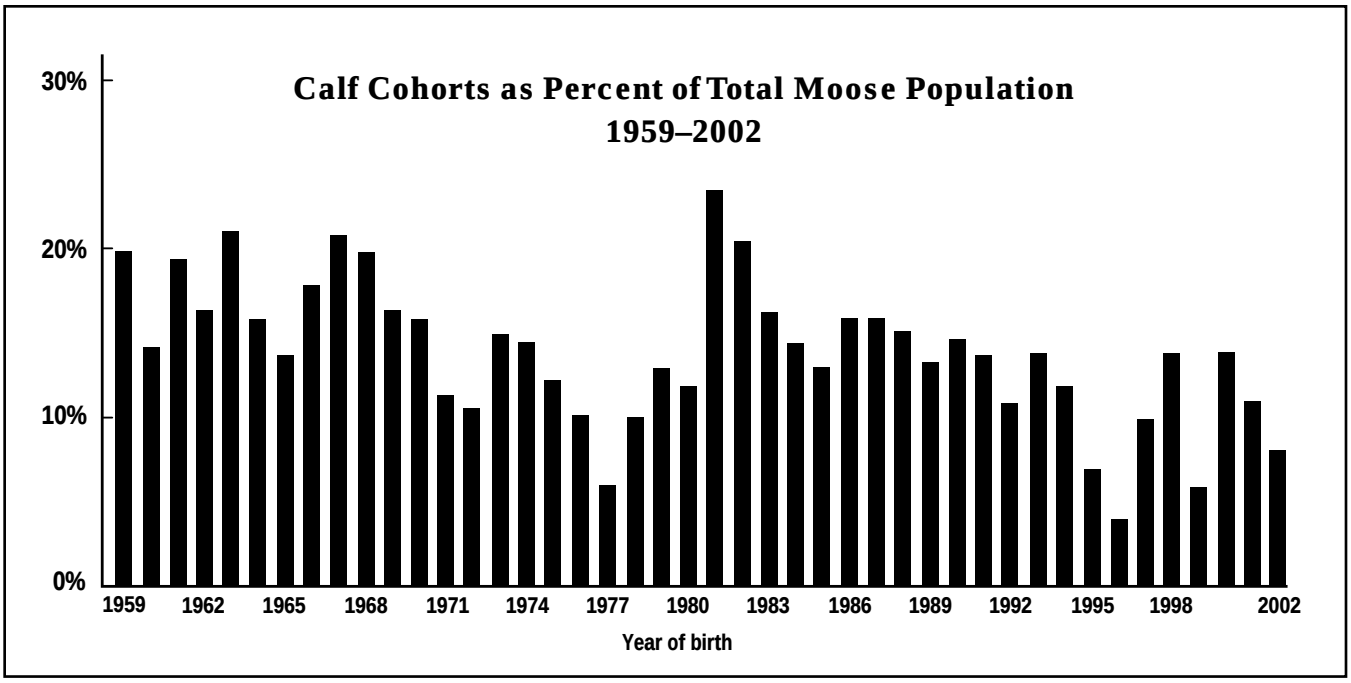


Figure 9. Moose calf abundance (at approximately six months of age) on Isle Royale, as a proportion of the total population. These are best estimates, a weighted mean of aerial counts in fall and/or winter.

Figure 10. Hair loss caused by accumulations of winter ticks was common in spring, 2002, when some mortality was attributed to a tick outbreak that was documented in moose populations across North America (photo by L. Vucetich).

latitudes of North America points to unusual weather as the cause. At Isle Royale and elsewhere, the common weather element seemed to be the unusually mild autumn and delayed winter in 2001. (In the western Lake Superior area, temperatures were above freezing and no snow fell until mid-December 2001.)

During the winter study in 2003, for the second year in a row, snow depth was minimal. Moose appeared to be distributed more uniformly across the island than normal, and there was at no time a noticeable concentration of moose in the usual winter habitats—conifer-dominated areas along shorelines. As usual, moose density was concentrated at the two ends of Isle Royale. The atypical distribution forced us to revise the stratification assignments for the moose census. Instead of four strata, in 2003 there were only two strata, "low" in the middle of the island and "high" at both ends. This plan minimized statistical variance, but the 95 percent confidence interval for the 2003 count was still +/- 25 percent.

In winter 2003, we were able to record moose mortality across the island for 44 days, based on snow-tracking and telemetry locations for packs, single

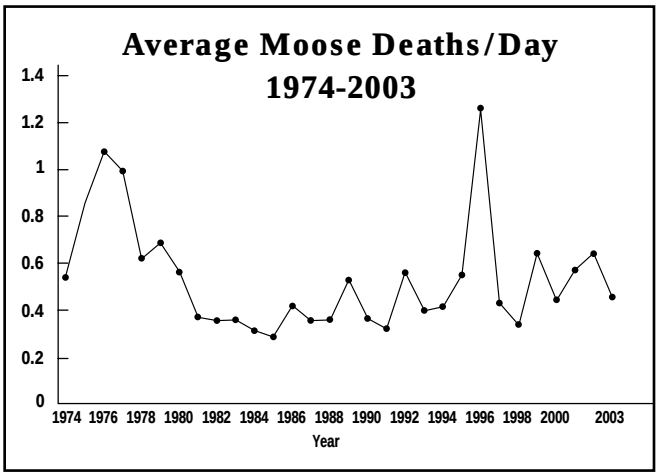


Figure 11. Moose mortality rate in midwinter was above average in 2003. All recorded moose mortalities resulted from wolf predation.

wolves and, occasionally, a temporary pair. Twenty moose were killed by wolves, the equivalent of 45 moose per 100 days. This is similar to the level of moose mortality in recent years (fig. 11).

Moose were able to forage without any restriction by snow during winter 2003, and marrow fat measurements of wolf-killed moose indicated that few were seriously malnourished. Mean marrow fat level for 3 calves and 12 older moose was 58 percent, consistent with levels found in moose over the past 3 years. In fact, recent marrow fat levels, when pooled over several adjacent years, have been higher than at any time in the past decade (fig. 12).

Steven Monfort (Conservation Research Center, National Zoological Park) has analyzed winter fecal samples from cow moose at Isle Royale for progesterone hormone, indicating pregnancy status. We suspect moose on the island may have a low pregnancy rate because of chronic nutritional limitation. Samples from 71 cow moose were analyzed from 2000-2002, and only 52 percent were judged pregnant (>5 micrograms/gram of progesterone). We will continue collections in subsequent years to evaluate annual and spatial variation. Hopefully, in another year, there will be an adequate fecal assay for determining sex of moose directly from winter pellets, so our determination of sex of moose will no longer require estimation from tracks and field sign. Other collaborations involved blending science with art (fig. 13).

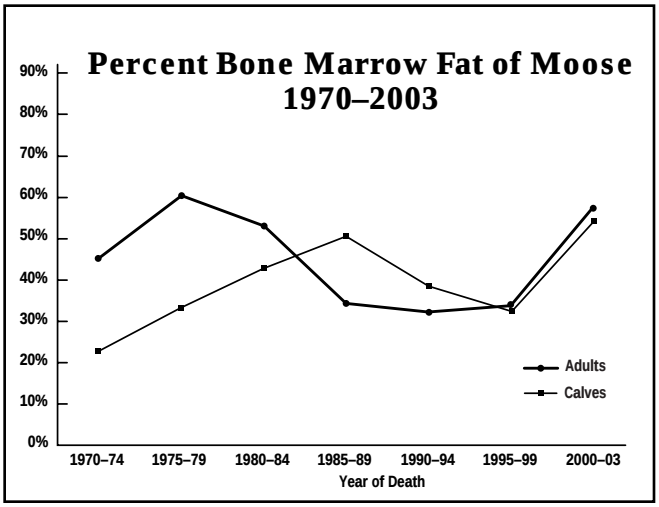
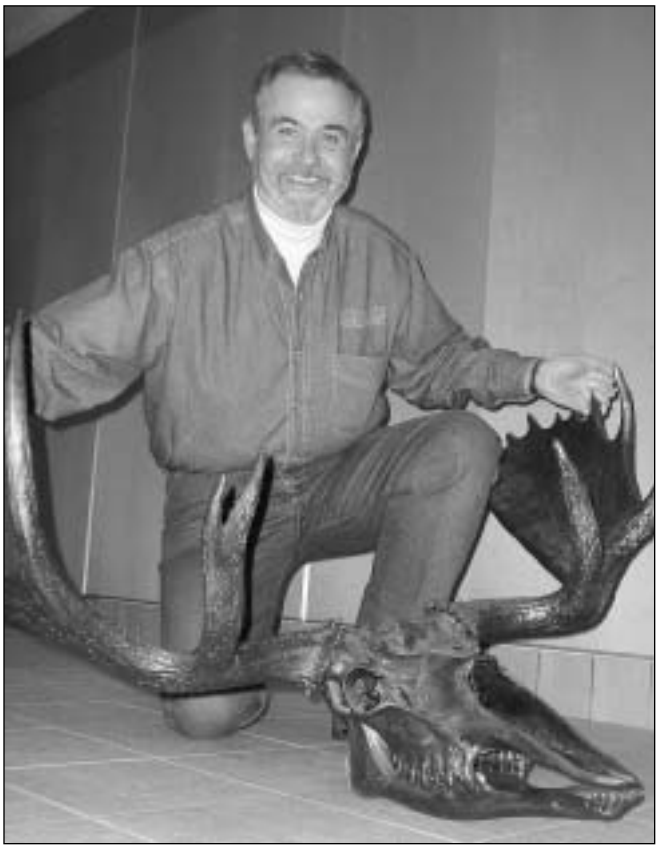


Figure 12. Long-term trends in moose bone-marrow fat. Data for calves (which best reflect current conditions) represent mean levels, whereas data for adults is the proportion with greater than 70 percent marrow fat. Taken together, marrow fat levels are higher than at any time in the past three decades.



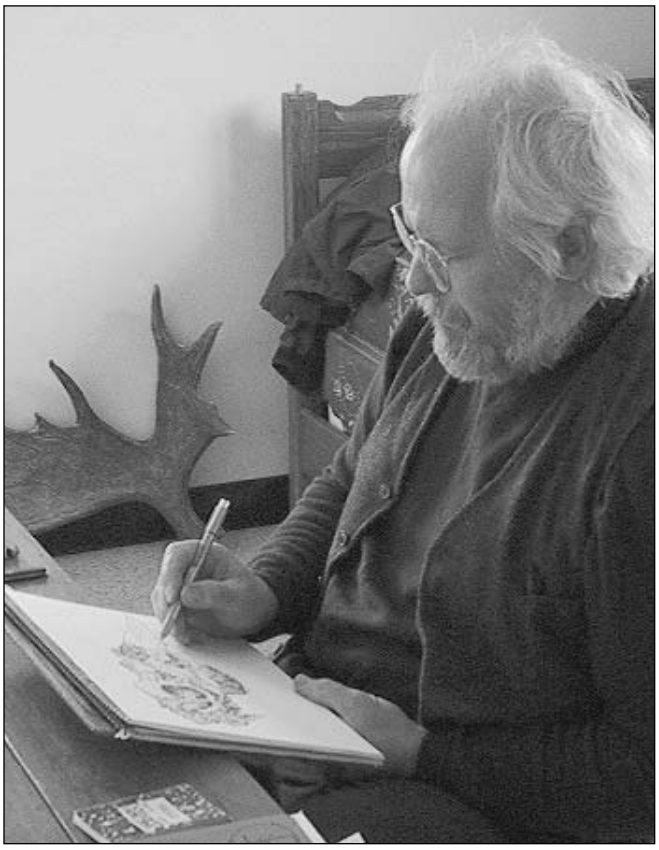


Figure 13. (Left) Phillip Barry, president of Mesalands Community College, in New Mexico, recently delivered a life-size bronze replica of the largest antlered skull from an Isle Royale moose (photo by J. Vucetich). The bronze casting was produced by students, faculty, and staff from the college. (Right) While visiting the winter study, bone artist Gendron Jensen generated images of wolf and moose bones.

Figure 14. All forest stands on Isle Royale are more than 50 years old. Here Candy Peterson could barely reach halfway round a very old aspen tree at the west end of Isle Royale, an area with no historic fires. The tree is probably over 200 years old, and ranks among the largest-diameter aspen trees in North America.

Forest Vegetation

The core food chain at Isle Royale consists of 19 wolves, about 900 moose, and some 123 million trees. These trophic layers are based on sampling intensities of 100%, 19%, and 0.001%, so the vegetation layer will require much attention before the full system can be understood. The terrestrial and aquatic vegetation of Isle Royale form the lowest trophic level, and we have initiated new studies of forest change in order to better understand resulting effects in mammal populations. Some of these changes are prompted by the intense herbivory of moose, while others relate to the recovery of the forests from human-caused fires over the past 170 years (fig. 14).

During the 1990s, changes in the forest affected moose distribution, so that presently half of the moose in winter occupy the northeastern third of the island. Two important changes that will influence carrying capacity for moose in the future are (1) the ongoing disappearance of balsam fir from two-thirds of the island, and (2) the slow succession from deciduous to coniferous tree species as the forests age (fig. 15).

Permanent plots for monitoring balsam fir populations were established in 1987, and additional measurement tools have been added since that time. At the southwest

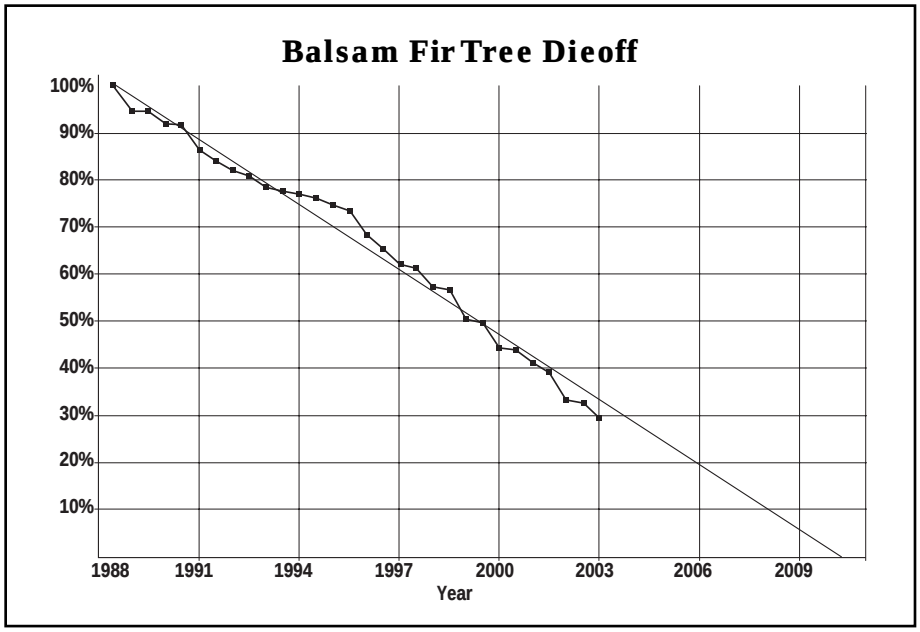


Figure 16. Balsam fir trees in the forest canopy that were tagged in 1988 have steadily died off without replacement. The remainder are expected to die by approximately 2010, and at that point a seed source for this species will be absent over 75 percent of Isle Royale. The demise of this species is ultimately caused by moose herbivory.

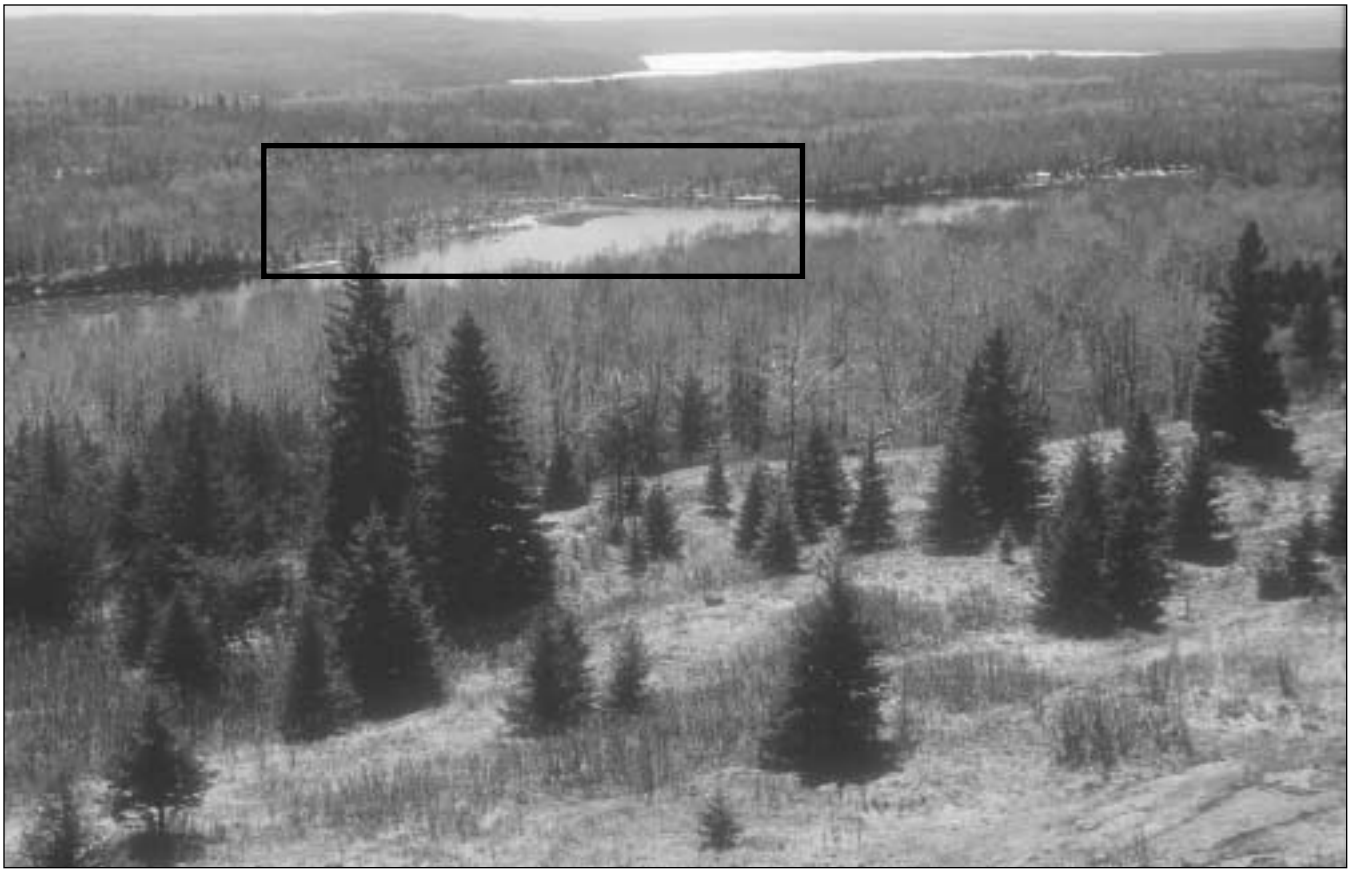


Figure 15. Looking south from Ojibway Fire Tower in 1974 (top) and 2002 (bottom), the establishment and growth of white spruce are evident. On the south shore of Lake Ojibway, extensive emergence of balsam fir is evident (box).

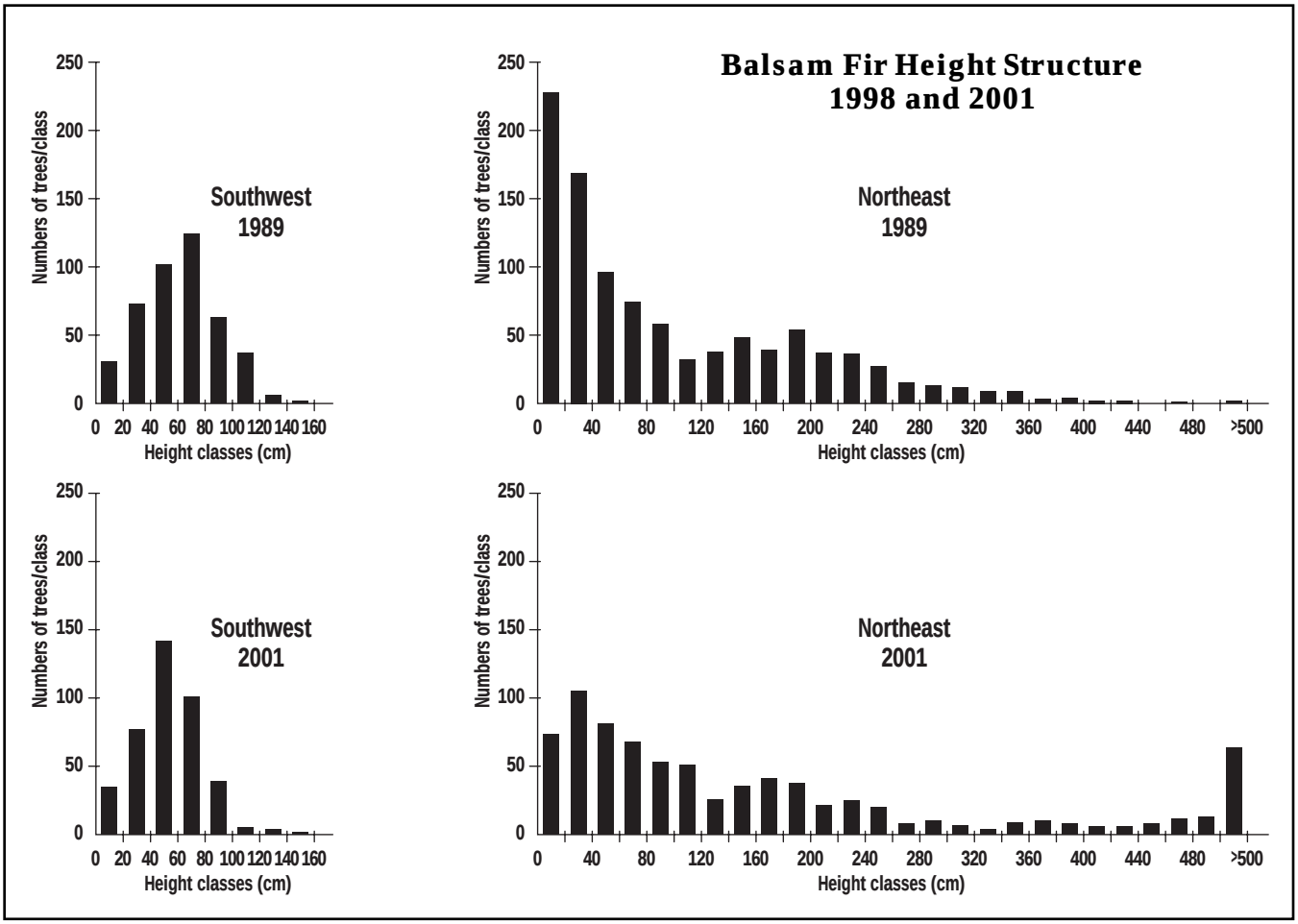


Figure 17. Height structure of balsam fir regeneration at the west and east ends of Isle Royale, 1989 and 2001, measured during successive counts on permanent plots with "high vigor" trees. West-end trees remain heavily suppressed by feeding moose, while east-end fir have escaped herbivory by growing out of reach.

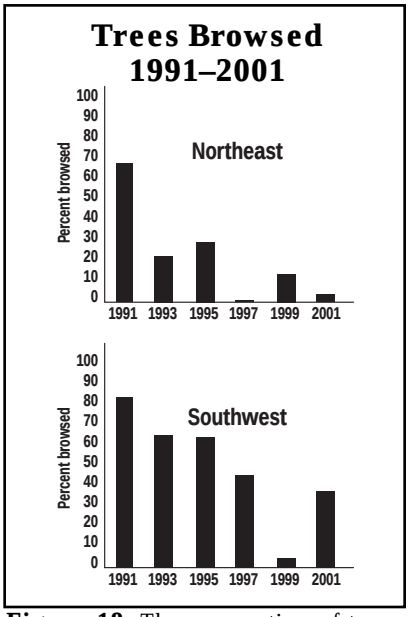


Figure 18. The proportion of trees browsed by moose has declined in the past decade, especially at the east end, yet height structure remains unchanged at the west end.

end of Isle Royale, survival of tagged fir trees in the forest canopy has been monitored since 1988. These trees, established before moose arrived on Isle Royale, are projected to die out by about 2010 (fig. 16). Seedlings established by that time will survive for a few decades, at most, but these trees are currently unable to grow beyond the reach of moose and to reproduce themselves. Fir provided almost 60 percent of winter browse intake in the mid-1980s, so the disappearance of this species will greatly affect moose carrying capacity.

Balsam fir continues to thrive at the northeastern end of Isle Royale, where the species exists at locally higher densities and seedlings can escape from intense moose herbivory to grow into reproducing trees (fig. 17). Earlier studies have suggested that the east end forests, on thin soils, prone to wind-throw disturbance, have a more open canopy that allows young fir to flourish in the well-lit forest understory. At the west end of Isle Royale, with well-developed soils on deep glacial till, a more complete canopy of mature deciduous trees shades the ground, reducing the ability of regenerating fir trees to grow. Even though moose did less damage to fir at the west end during the 1990s, especially after the moose die-off in 1996 (fig. 18), there was little improvement in fir status there (fig. 17). In 2003, we will intensify our studies of fir not only to track performance of individual trees but also to conduct more extensive searches for fir stems that appear to be escaping moose pressure, as they might provide a seed source sufficient to maintain the species.

Turning Terror into Triumph?

Three years ago, in a sidebar entitled "Endurance and Opportunity," I may have underestimated both qualities as I chronicled the survival of a female wolf. Loyal readers may recall how, after evading capture in an all-out run of six miles, a desperate female wolf leaped into Lake Superior. She was then set upon by 11 members of the Middle Pack. Coming upon this scene, pilot Don Glaser and I watched for an hour as the female, cowering on a slippery reef, was repeatedly attacked. Finally she attempted escape after swimming a distance down the shore, but the Middle Pack wolves ran her down, savagely beat her up once more, and left her for dead.

In a fairy-tale ending, a wandering male from the Middle Pack finally arrived, and his behavior left no doubt that the female victim was in heat. While initially she could barely lift her head for a few seconds, within hours she rose and disappeared into the forest with her new-found companion. In another 12 hours, her wounds had stopped bleeding and the pair left the area. Five days later, on the last flight of the winter, we found the pair holed up about a half mile from the point of attack, the female now standing while the male attentively licked the wounds on her neck (see photo, compare to fig. 4). Here is where the known facts of this saga end.

During the next summer (2000), however, a pair of wolves successfully carved out a piece of East Pack territory and raised one pup, less than 2 miles from where the female survived the attack. Unexpectedly, this pack flourished in 2001-2002 and managed to push the East Pack aside, killing two and possibly several more members of that pack in the process. (The pack lost four more wolves that year.) Raising litters of pups in both 2001 and 2002, the new pack grew to six animals by 2003 and then began making exploratory forays into Middle Pack territory. This vigorous pack, now named the "Chippewa Harbor Pack," displays the energy of its indomitable leaders. In following this new pack around the middle of the island, I like to think that the resurrected female still leads the tribe.

Other Wildlife

The National Park Service conducts aerial and ground surveys of osprey and bald eagle nests each summer. There was little change from the number of nest sites counted in 2001. Eagle nests dropped from 12 to 11, with 11 young fledged. The number of osprey nests was unchanged, at 7, with 7 young fledged.

Snowshoe hare observations were down in summer 2002, consistent with a cyclical decline following a peak at the turn of the decade (fig. 19). Red fox, a major hare predator, have likewise declined to low levels (fig. 20).

Beaver colonies were counted during an aerial survey by Douglas W. Smith and Philip C. Shelton in October 2002. The number of colonies was identical to a similar count in 2000, suggesting that the rate of decline in beaver numbers

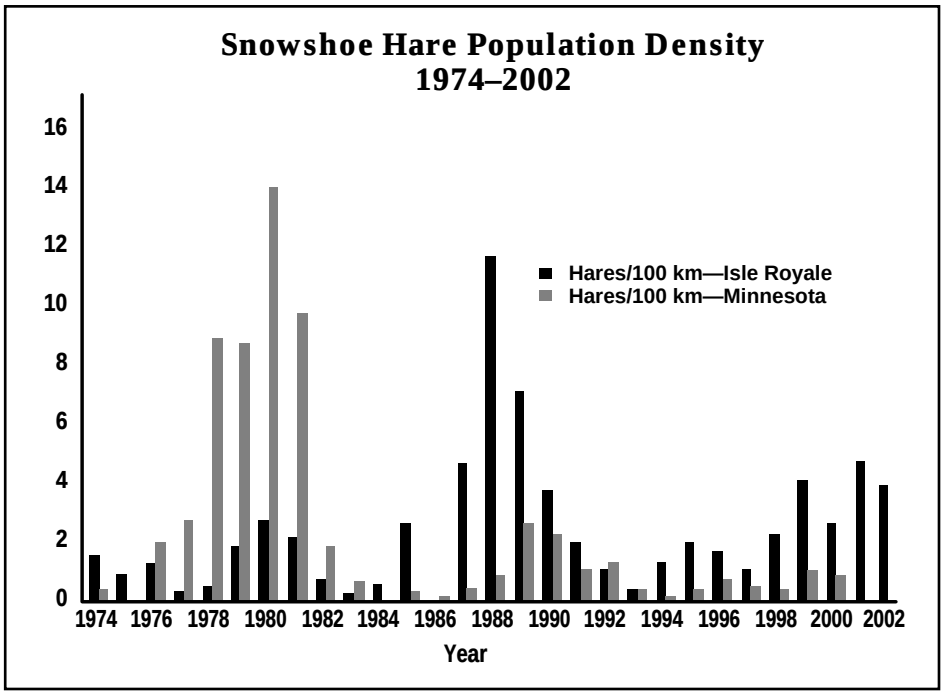


Figure 19. Relative snowshoe hare density reaches a peak around the beginning of each new decade, both at Isle Royale and on the mainland in Minnesota. Counts were made at Isle Royale during all hikes in May-August, while hares were counted in Minnesota on routes used to count drumming ruffed grouse in spring (Minnesota Department of Natural Resources, with thanks to William E. Berg).

(ultimately caused by aging of the forest) may be slowing down (fig. 21). Aging forests that were established following wildfire in the 19th and early 20th centuries have become dominated by coniferous tree species, providing little forage for beaver (fig. 22). Because of the island's geography, most of the beaver colonies are at the east end (fig. 23), where the terrain is more variable. Otter are likewise more common at the east end (fig. 24).

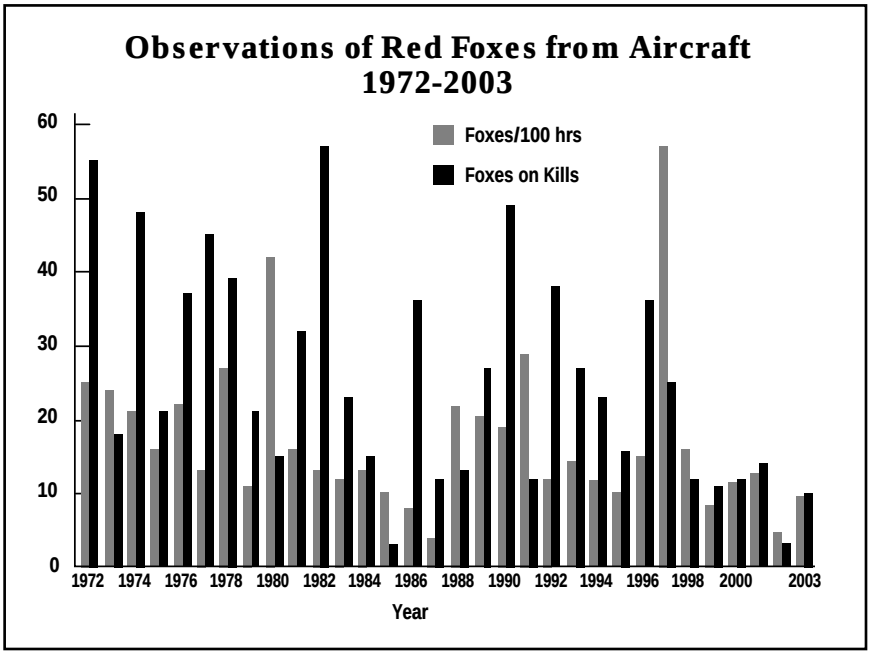


Figure 20. Relative abundance of red foxes from aircraft observations in winter, 1972-2003. Grey bar is the number of foxes seen away from moose carcasses/100 hours, while the black bar is the number of foxes seen on carcasses.

Figure 22. Beaver pond photographed in 1974 (left) was a meadow in 1999 (right), providing substrate for a developing spruce forest. Photo points varied slightly, but the large spruce tree appears in both photos.

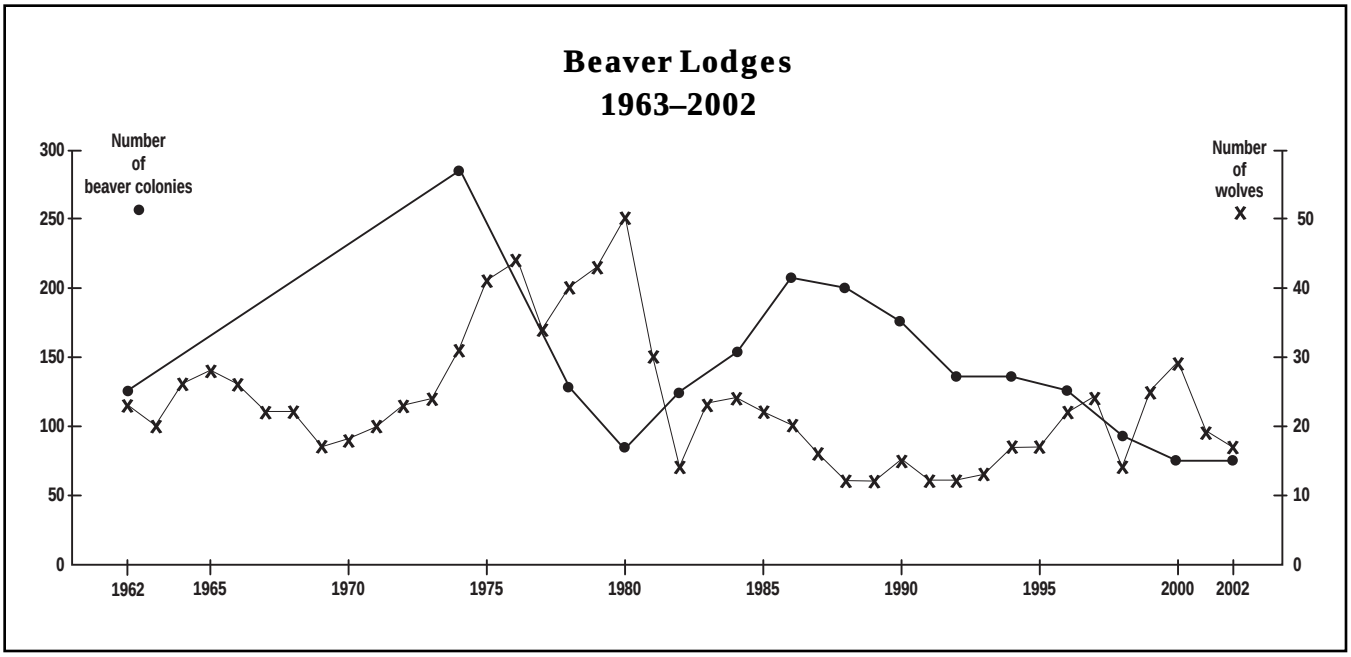


Figure 21. Aerial counts of occupied beaver lodges indicate that beaver numbers have declined to relatively low levels, as the older forests emerging at Isle Royale provide less forage for beaver.

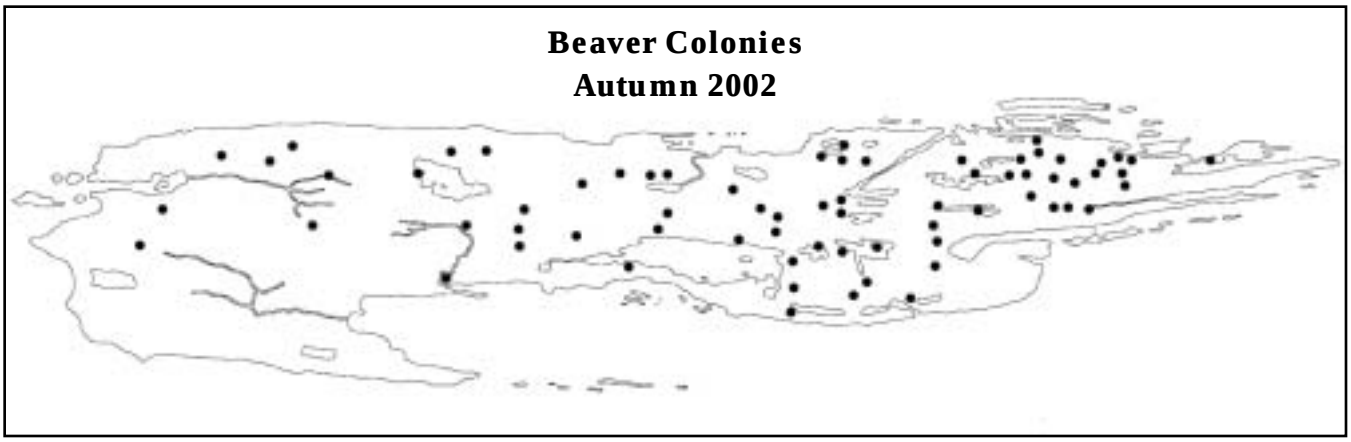


Figure 23. Active beaver colonies mapped by D.W. Smith and P.C. Shelton in October 2002.

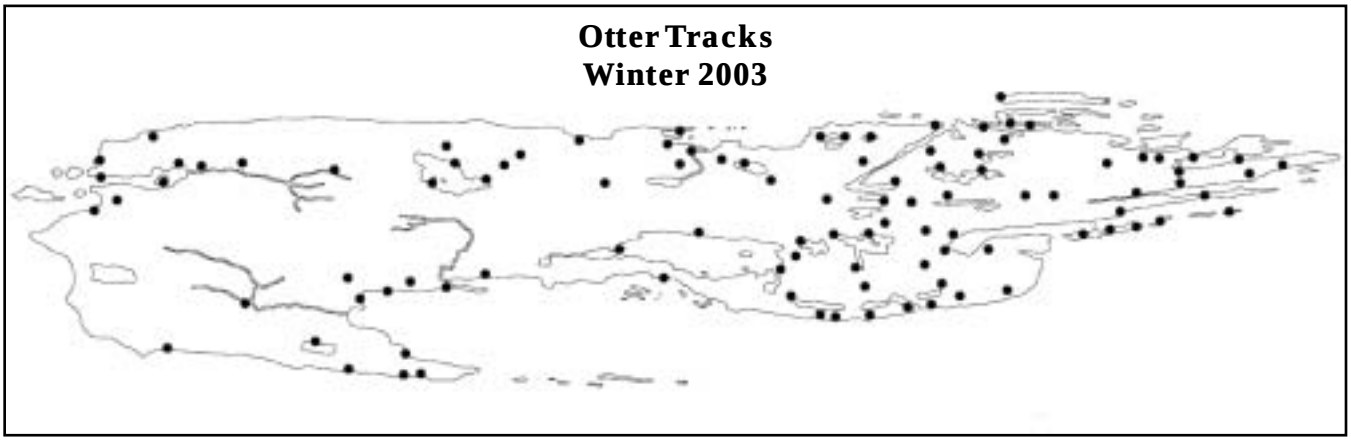


Figure 24. Location of otter tracks during winter aerial surveys.

Weather, Snow, and Ice Conditions

Shoreline ice on Lake Superior was sparse and snow was virtually absent when the winter study began in early January 2003. Below-normal temperatures prevailed during the winter study period, so shoreline ice quickly accumulated. High winds prevented an ice bridge from forming between Isle Royale and the Ontario mainland, but it is likely that an ice bridge existed for a couple of weeks in early March, after the study ended. Snow depth eventually built up to the 25-cm mark, only about half the usual level (fig. 25).

In 2003, the distinctive weather characteristics were sustained low temperatures (fig. 25) and high winds. The exceptionally strong winds severely restricted the aerial survey effort in 2003. Excellent flying conditions require wind speeds of less than ~25km per hour. In a typical year, calm conditions prevail about 40 percent of the time. This year, however, winds were less than 25 km/h only 23 percent of the time. Also, winds exceeded 50 km/h for 14 percent of the time, almost twice the usual level (fig. 25).

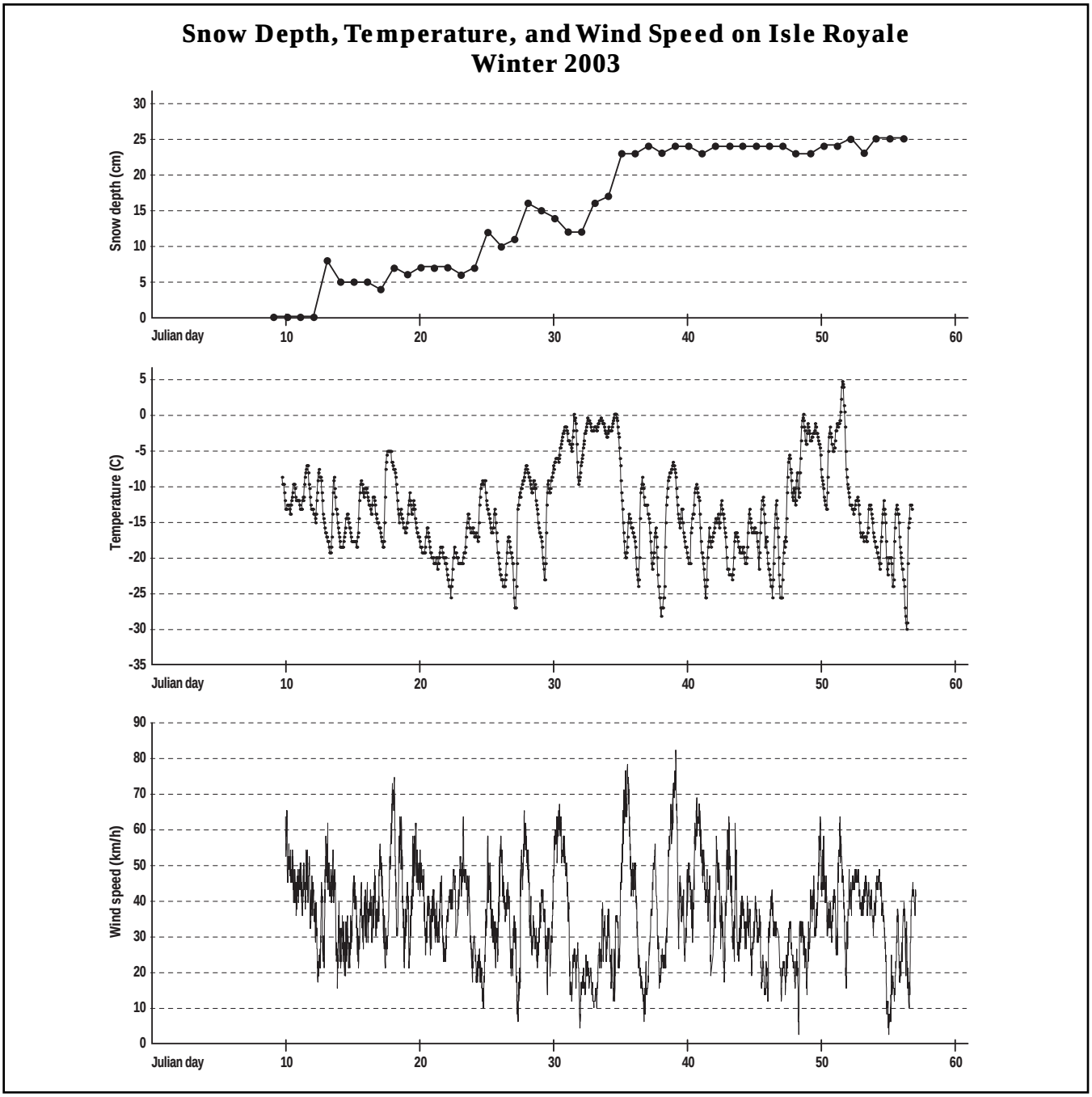


Figure 25. Snow depth (daily), ambient temperature (hourly), and wind speed (every 10 minutes, measured at Rock of Ages lighthouse) during the 2003 winter study on Isle Royale.

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