ECOLOGY AND POPULATION DYNAMICS OF BLACK BEARS IN MINNESOTA

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SUMMARY OF FINDINGS

During April 2017–March 2018, we monitored 16 American black bears (*Ursus americanus)* previously radiocollared (mostly with GPS collars) at 4 study sites representing contrasting portions of the bear's geographic range in Minnesota: Voyageurs National Park (VNP, northern extreme, poorest food), Chippewa National Forest (CNF; central), Camp Ripley Training Center (southern fringe), and a site at the northwestern (NW) edge of the range. During summer, we captured and collared 8 more bears. We did not collar young males, which are likely to disperse; however, most of the capture sample was young males — indicative of heavy hunting pressure. Hunting has been the primary source of mortality in all areas, although vehicle collisions have been a significant source of mortality for bears wandering off Camp Ripley, which is flanked by highways. In the 2017 hunting season, 22% of collared bears on the CNF were legally shot, even though hunters were asked to avoid killing collared bears, and each was marked with conspicuously large, colorful ear tags.

Reproduction was strongly affected by food supply. The NW area had the highest reproductive rate, due to early maturity, large litters, and litter intervals rarely exceeding 2 years. Camp Ripley bears matured early but had the highest proportion of 3-year litter intervals. Litter sizes of 3 were most common in NW and CNF, whereas litter sizes of 2 were most common in VNP; in Camp Ripley, 3-year-old mothers all had litters of 2, whereas older mothers had an equal proportion of 2- and 3-cub litters.

Camera traps set outside den sites revealed widely varying dates of initial den emergence (22 Feb−18 April) and final departure from the den site 0–42 days later. Much of the bears' activity outside the den, before leaving the den site, involved collecting dry bedding material. Photos showed that bears often got wet in their dens from melting snow, resulting in the death of 1 cub.

INTRODUCTION AND STUDY AREAS

Telemetry-based research on black bears was initiated by the Minnesota Department of Natural Resources (MNDNR) in 1981, and has been ongoing continuously since then. Objectives shifted over the years, and study areas were added to encompass the range of habitats and food productivity across the bear range. For the first 10 years, the bear study was limited to the Chippewa National Forest (CNF), near the geographic center of the Minnesota bear range (Figure 1). The CNF is one of the most heavily hunted areas of the state, with large, easily-accessible tracts of public (national, state, and county) forests dominated by aspen (*Populus tremuloides, P. grandidentata)* of varying ages. Camp Ripley Training Center, a National Guard facility at the

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southern periphery of the bear range, was added as a second study site in 1991. Camp Ripley is unhunted, but bears may be killed by hunters when they range outside Camp, which they often do in the fall. Oaks (*Quercus* sp.) are plentiful within Camp, and cornfields border the site. Voyageurs National Park (VNP), at the northern edge of the Minnesota range (but bordering bear range in Canada) was added as a third study site in 1997. Soils are shallow and rocky in this area, and foods are generally less plentiful than in the other sites. Being a national park, it is unhunted, but like Camp Ripley, bears may be hunted when they range outside VNP.

In 2007, we initiated work in a fourth study site at the northwestern edge of the Minnesota bear range (henceforth NW; Figure 1). This area differs from the other 3 areas in a number of respects: (1) it is largely agricultural (including crop fields, like corn and sunflowers that bears consume), (2) most of the land, including various small woodlots, is privately owned, with some larger blocks of forest contained within MNDNR Wildlife Management Areas (WMAs) and a National Wildlife Refuge (NWR); (3) the bear range in this area appears to be expanding and bear numbers have been increasing, whereas, until recently, most other parts of the bear range have had stable or declining bear numbers; and (4) hunting pressure in this area is unregulated (it is within the no-quota zone, so there is no restriction on hunting licenses).

We used these 4 study sites to examine spatial variation in bear population dynamics and ecology to help inform bear management.

OBJECTIVES

1. Compare sources of bear mortality in different parts of the bear range.
2. Quantify temporal and spatial variation in cub production and survival.
3. Understand factors affecting emergence and departure from dens.

METHODS

During May−August, 2016, we captured bears in the CNF with barrel traps and immobilized them with ketamine-xylazine. During December–March, we visited all radiocollared bears once or twice at their den site and immobilized them with Telazol. For all handling, we measured and weighed bears, assessed body condition, took blood and hair samples, and extracted a vestigial first premolar to estimate age on all bears whose age was unknown (i.e., first handling of bears older than cubs). We changed or refit the collar, as necessary. We collared all new females and larger males that we thought would not disperse from the study area.

This year we used mainly GPS-Iridium collars (Telonics Inc., Mesa, AZ) or VHF collars with an attached GPS pod (Telemetry Solutions, Concord, CA), except in VNP where we used only VHF collars. All collared bears had brightly-colored, cattle-size ear tags (7x6 cm; Dalton Ltd., UK) that would be plainly visible to hunters. Bears that were not collared had small inconspicuous ear tags.

We monitored survival of bears during the summer. Mortalities also were reported to us when bears were shot as a nuisance, hit by a car, or killed by a hunter. Licensed hunters could legally shoot collared bears, although they were asked not to. Prior to the hunting season (1 September–mid-October), hunters were mailed a letter requesting that they not shoot collared bears with large ear tags, and this request was also made through news releases. Requests to hunters to voluntarily not shoot collared bears have been made through the news media and MNDNR hunting regulations and website since 2001, although the individual letters to hunters was not initiated until 2011.

We assessed reproduction by observing cubs in March dens. We sexed and weighed cubs without drugging them. We quantified cub mortality by examining dens of radiocollared mothers the following year; cubs that were not present as yearlings with their mother were presumed to have died.

We monitored heart rates of a subset of bears using a new Insertable Cardiac Monitor developed for human heart patients (Reveal LINQ™, Medtronic Inc., Minneapolis, MN). The device provided wireless transmission of heart and activity data to an antenna buried under the nest material in the den, which was then relayed by cell phone to a base station (see Laske et al. 2014). These data are not presented in this report, but will be used to inform our research questions about factors affecting den emergence.

We set remote cameras (camera traps; Reconyx, Inc., Holmen, WI) outside bear dens to gain information about dates and behaviors of bears emerging from dens and departing from the den site. Bears that emerged from dens <48 hours after our den visit were excluded from the analysis.

RESULTS AND DISCUSSION

Radiocollaring and Monitoring

As of April 2017, the start of the current year's work, we were monitoring 25 radiocollared bears: 16 in the CNF, 5 at Camp Ripley, 2 in VNP, and 2 in the NW (Table 1).

In early spring we collared and released in the CNF 1 previously orphaned cub that was raised in a rehabilitation center until it was 1 year old and self-sufficient. We were interested in how this bear used the habitat. Normally we do not collar rehabbed bears and do not release them in a study site.

During May–July we captured 11 new bears (9M; 2F) in the CNF, and collared 6. We also caught and collared 2 bears that had previously been caught in 2016 but were deemed too young to collar then. We avoided collaring small males, supposing they would disperse. Our capture sample, though, over the past 3 years was heavily skewed toward males (31 of 40 = 76%) and young bears (80% 1–4 years old); only 4 captured bears were >6 years old (Figure 2). The heavy skew toward males and young age structure of the captured bears suggests that this area has been subjected to heavy hunting, and many of the bears had immigrated from elsewhere.

At Camp Ripley we collared 2 adult females that were found in den sites, and also collared 3 female yearlings that were denned with 2 collared mothers.

Mortality

Since 1981 we have recorded the cause of death for 383 radiocollared bears, 76% of which died (or likely died) from legal hunting (Table 2). In all 4 study sites, legal hunting was the primary cause of mortality (Figure 3), despite (a) Camp Ripley and VNP being unhunted (but bears wander outside during fall on foraging trips, and (b) hunters being asked to not shoot collared bears with large ear tags for the past 17 years (spanning the full period of the NW study).

During the 2017 bear hunting season, 5 collared bears were shot in the CNF (Table 1). This represented 22% of the collared bears monitored at the time, and included 3 of 7 collared adult females. This high (unsustainable) harvest rate among collared bears was similar to last year, and is further evidence that the CNF study site is a population sink (where mortality exceeds reproduction, and there is a high rate of immigration of young males).

Vehicle collisions are another significant source of mortality. We found one CNF adult male dead in July 2017, but he was too decayed to ascertain cause of death directly; however, his GPS locations and mortality sensor showed that he died Memorial Day weekend, 2 days after crossing a busy highway (Highway 38), and he died within 0.25 miles of the road, so we strongly suspect he was hit by a vehicle. Vehicle collisions are most common at Camp Ripley (Figure 3), which is flanked by 2 highways. One collared adult female, who had been monitored since 2004 and had produced 15 cubs since then, was hit and killed on a highway just outside Camp Ripley (4-lane U.S. Highway 10) in July 2017. We had previously implanted a heart monitor in this bear, and observed that her heart rate increased dramatically as she crossed the road (based on matching the data from the heart monitor with GPS collar; Ditmer et al. 2018, Supplement). This bear had crossed busy roads frequently in other years, because she lived mainly outside Camp Ripley; she had crossed this highway at least 10 times in the 2 months between emerging from her den and being killed.

Reproduction

Since 1982, within the 4 study areas, we have checked 297 litters with 766 cubs (mean = 2.6 cubs/litter; range = 2.2–2.8 by study site), of which 50.3% were male (Tables 3–6). All bears that were expected to have cubs this year, based on a 2-year reproductive cycle, did so. Overall, bears at Camp Ripley, despite being large, have had a higher rate of missed litters (3-year litter intervals) than bears in the other study sites (Table 7).

We observed 2 bears that produced their first litters this year in the CNF, 1 at 4 years old and 1 at 5. Two 4 year-old females in the VNP did not produce cubs. Since the beginning of the study, 38% of females in the CNF produced cubs by 4 and none in the VNP produced cubs by 4, whereas 85% of females in the other 2 study sites produced cubs by 4 years old (Figure 4).

Bears in the CNF and NW produced more 3-cub litters than 2-cub litters, whereas 2-cub litters were most common at Camp Ripley and VNP (Figure 5). The relatively small litter sizes at Camp Ripley were due to many of those bears producing cubs when only 3 years old (all 3-year-old mothers had litters of 2 cubs). Eliminating these bears, litter sizes of 2 and 3 cubs were about equal at Camp Ripley (Figure 5). Among all study sites combined, 35% of bears had litters of 2 cubs, and 54% had litters of 3.

Camp Ripley bears apparently sacrificed litter size for earlier age of reproduction (Figures 5 and 4, respectively). NW bears had both large litters and early age of first reproduction, so were most prolific of all the sites.

Reproductive rates (cubs/female 4+ years old: combining litter size, litter frequency, and age of first reproduction into a single parameter) were highest in the NW study area, and lowest in VNP (Figure 6). This is somewhat ironic in terms of Minnesota's bear management, given that the NW study site is outside "core" bear range and, accordingly, is within a management zone where bear hunting license sales are unrestricted (no-quota). The NW site contains not only agricultural crops consumed by bears, but also an abundance of natural foods, especially along the edges of woodlots (Ditmer et al. 2015). In all areas except the NW, reproductive rates were higher for ≥7-year-old bears than 4- to 6-year-olds because many bears in this younger age group either had not yet reproduced or just had their first litter, which tended to be smaller (fewer cubs). The most striking differences among study sites were in the reproductive rates of these 4–6 year-olds (Figure 6).

Mortality of cubs during their first year of life averaged 19% (annual range 0–31% for years with at least 10 cubs monitored), with mortality of male cubs (24%) exceeding that of females (16%; $\chi^2 = 6.15$, $P = 0.01$). However, in the most recent 15 years on the CNF (2004–2018), female cub mortality equaled that of males, and so overall cub mortality increased from 17% (1982–

2003) to 29% ($\chi^2 = 4.1$, $P = 0.04$). The timing and causes of cub mortality are unknown (but see below for 1 case this year where it was observed)

Camera Trap Photos at Dens

We obtained camera-trap photos of bears that yielded dates of natural emergence and departure from 30 dens: 1 in 2015, 6 in 2016, 7 in 2017, and 16 in 2018. Dates of first emergence ranged from 22 February to 18 April (Figure 7). After first emergence (which we defined as completely exiting the den, not just poking their head out), bears remained at the den site for 0−42 days. This span of time is similar to that reported by Miller et al. (2016; 0−47 days) for 21 black bear dens monitored with camera traps in Utah. In our study, mean date of first emergence was highly variable, and widely overlapping for solitary bears (of either sex), females with yearlings, and females with cubs. However, females with cubs left the den site about 1 week later (mean = April 6) than other bears (mean = March 30; although the 2 oldest and largest males [>400 lbs] left on April 18 and 26).

We observed no relationship between the dates that bears first emerged from dens and when they eventually left the site (Figure 7). We suspect that bears employed different thresholds for leaving. Bears with young cubs tended to stay until cubs were mobile and able to climb trees. Solitary bears or mothers with yearlings often waited for most of the snow to melt; however, some did not. This year we deployed temperature sensors inside dens, just outside dens, and on each bear's collar, hoping to better understand the effect of temperature (and especially, increasingly warming springs) on bear denning habits. These data have not yet been analyzed.

Between the time of emergence and eventual departure from the den site, bears moved back and forth between their den and outside the den. When outside the den, but before leaving the vicinity of the den (defined as beyond the detection of the remote cameras), bears were involved in the following principal behaviors: raking more bedding material into the den, stretching/walking, laying in the sun, eating snow or drinking water, monitoring cubs playing and climbing trees (Figure 8). We thus interpret the period between den emergence and departure to be a time when bears: (1) attempt to stay dry in the den while snow is melting and causing some discomfort; (2) regain muscle strength; (3) warm body temperature; and (4) rehydrate. Often, in March, we observed bears poking their head outside the den to eat snow while not coming completely out of the den (Figure 8). Hibernating bears do not eat or drink through the winter, but in the month before leaving the den site, they sought to rehydrate.

Although we have not yet quantified time by activity, the photographs in our study indicate a substantial investment in gathering more bedding material. In fact, it often appeared that the primary reason for coming out of the den was to get more bedding, apparently because the den had gotten wet; in some cases, the photos clearly showed that bears had gotten wet in their dens. In one case, a female with 4 cubs in the NW study site had an excavated den that became saturated when a nearby river thawed and rose; she carried her wet cubs individually out of the flooded den and placed them in a nest of grass that she built behind her den (Figure 9). The last cub that she removed was limp and appeared to have died — we later found a dead cub in the nest. In another case, a female with cubs left her flooded den site on April 12; just 11 days later our remote camera photographed a female wood duck (*Aix sponsa*) on the ephemeral pond just outside the former den (Figure 10).

Camera traps and GPS collars were not available when we began our research >30 years ago, so we cannot ascertain whether spring flooding of dens was as common then as it is now. However, our long-term data seem to show a trend toward increased selection of above-ground dens, which are drier than excavated dens, but expose bears to other potential environmental hazards.

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Table 1. Fates of radiocollared black bears in Chippewa National Forest (CNF), Camp Ripley, Voyageurs National Park (VNP), and northwestern Minnesota (NW) study sites, April 2017−March 2018.

	CNF	Camp ripley	VNP	NW
Collared sample April 2017	16	5	2	2
Trapped and collared	8			
Collared in den		5		
Released from rehab	1			
Killed in vehicle collision	1[b]	1		
Killed by Minnesota hunter[a]	5			
Died from unknown causes				
Removed radiocollar	1			
Dropped radiocollar	1			
Collared sample April 2018	17	9	2	2

[a] Hunters were asked not to shoot collared bears (although it was still legal).
[b] Uncertain cause of death, but crossed a busy highway 2 days before dying close to the road.

Table 2. Causes of mortality of radiocollared black bears ≥1 year old in 4 Minnesota study sites, 1981–2018. Bears did not necessarily die in the area where they usually lived (e.g., hunting was not permitted within Camp Ripley or VNP, but bears were killed by hunters when they traveled outside these areas).

	CNF	Camp ripley	VNP	NW	All combined
Shot by hunter[a]	235	13	16	14	278
Likely shot by hunter[b]	9	1	0	4	14
Shot as nuisance	22	2	1	3	28
Vehicle collision	13	10	1	3	27
Other human-caused death	9	1	0	0	10
Natural mortality	8[c]	3	5	0	16[c]
Died from unknown causes	5	2	0	3	10
Total deaths	301	32	23	27	383

[a] Since 2001, the MNDNR has asked hunters not to shoot collared bears, so the proportion killed due to this cause is no longer representative of the population at large.
[b] Lost track of during the bear hunting season, or collar seemingly removed by a hunter.
[c] Only 1 bear died of “old age”.

Table 3. Black bear cubs examined in dens of radiocollared mothers in or near the Chippewa National Forest, Minnesota, during March, 1982–2018. High hunting mortality of radiocollared bears severely reduced the sample size in recent years.

Year	Litters checked	Number of cubs	Mean cubs/litter	% Male cubs	Mortality after 1 year[a]
1982	4	12	3.0	67%	25%
1983	7	17	2.4	65%	15%
1984	6	16	2.7	80%	0%
1985	9	22	2.4	38%	31%
1986	11	27	2.5	48%	17%
1987	5	15	3.0	40%	8%
1988	15	37	2.5	65%	10%
1989	9	22	2.4	59%	0%
1990	10	23	2.3	52%	20%
1991	8	20	2.5	45%	25%
1992	10	25	2.5	48%	25%
1993	9	23	2.6	57%	19%
1994	7	17	2.4	41%	29%
1995	13	38	2.9	47%	14%
1996	5	12	2.4	25%	25%
1997	9	27	3.0	48%	23%
1998	2	6	3.0	67%	0%
1999	7	15	2.1	47%	9%
2000	2	6	3.0	50%	17%
2001	5	17	3.4	76%	15%
2002	0	0	—	—	—
2003	4	9	2.3	22%	0%
2004	5	13	2.6	46%	33%
2005	6	18	3.0	33%	28%
2006	2	6	3.0	83%	33%
2007	2	6	3.0	67%	17%
2008	1	3	3.0	100%	33%
2009	1	3	3.0	33%	33%
2010	1	4	4.0	100%	50%
2011	1	4	4.0	25%	50%
2012	1	3	3.0	67%	33%
2013	1	3	3.0	67%	0%
2014	1	3	3.0	67%	—[b]
2015	0	0	—	—	—
2016	0	0	—	—	—
2017	1	3	3.0	—	0%
2018	4	12	3.0	42%	—
Overall	184	487	2.6	53%	19%

[a] Cubs that were absent from their mother's den as yearlings were considered dead.
[b] Mother was killed by a hunter so status of cubs unknown.

Table 4. Black bear cubs examined in dens in northwestern Minnesota during March, 2007–2018.

Year	Litters checked	Number of cubs	Mean cubs/litter	% Male cubs	Mortality after 1 year
2007	2	6	3.0	33%	100%
2008	5	15	3.0	67%	22%
2009	1	3	3.0	33%	33%
2010	6	17	2.8	41%	13%
2011	2	4	2.0	75%	25%
2012	4	10	2.5	60%	10%
2013	3	9	3.0	67%	18%
2014	3	8	2.7	0%	33%
2015	2	5	2.5	60%	0%
2016	2	6	3.0	50%	0%
2017	1	3	3.0	0%	0%
2018	1	4	4.0	50%	
Overall	32	90	2.8	44%	16%[a]

[a] Excludes the total loss of a 5-cub litter in 2007 (which was not within the designated study area).

Table 5. Black bear cubs examined in dens in or near Camp Ripley Training Center, Minnesota, during March, 1992–2018.

Year	Litters checked	Number of cubs	Mean cubs/litter	% Male cubs	Mortality after 1 year[a]
1992	1	3	3.0	67%	0%
1993	3	7	2.3	57%	43%
1994	1	1	1.0	100%	—
1995	1	2	2.0	50%	0%
1996	0	0	—	—	—
1997	1	3	3.0	100%	33%
1998	0	0	—	—	—
1999	2	5	2.5	60%	20%
2000	1	2	2.0	0%	0%
2001	1	3	3.0	0%	33%
2002	0	0	—	—	—
2003	3	8	2.7	63%	33%
2004	1	2	2.0	50%	—
2005	3	6	2.0	33%	33%
2006	2	5	2.5	60%	—
2007	3	7	2.3	43%	0%
2008	2	5	2.5	60%	0%
2009	3	7	2.3	29%	29%
2010	2	4	2.0	75%	25%
2011	3	8	2.7	50%	25%
2012	1	2	2.0	100%	0%
2013	6	14	2.3	50%	21%
2014	1[b]	—[b]	—	—	—
2015	6	15	2.5	20%	10%
2016	0	0	—	—	—
2017	4	10	2.5	60%	0%
2018	2	5	2.5		—
Overall	52	124	2.4	48%	18%

[a] Blanks indicate no cubs were born to collared females or collared mothers with cubs died before the subsequent den visit to assess cub survival.
[b] Cubs heard, litter not handled. Camera set outside den indicated that all cubs died. This litter not included in total.

Table 6. Black bear cubs examined in dens in Voyageurs National Park, Minnesota, during March, 1999–2018. All adult collared females were killed by hunters in fall 2007, so no reproductive data were obtained during 2008–2009.

Year	Litters checked	Number of cubs	Mean cubs/litter	% Male cubs	Mortality after 1 year[a]
1999	5	8	1.6	63%	20%
2000	2	5	2.5	60%	80%
2001	3	4	1.3	50%	75%
2002	0		—	—	—
2003	5	13	2.6	54%	8%
2004	0		—	—	—
2005	5	13	2.6	46%	20%
2006	1	2	2.0	50%	0%
2007	3	9	3.0	44%	—
2008	0		—		—
2009	0		—		—
2010	1	2	2.0	50%	0%
2011	1	2	2.0	0%	0%
2012	1	2	2.0	0%	50%
2013	1	2	2.0	50%	—
2014	1	3	3.0	33%	0%
2015	0	0	—	—	—
2016	0[b]	0	—	—	—
2017	0	0	—	—	—
2018	0	0	—	—	—
Overall	29	65	2.2	48%	25%

[a] Blanks indicate no cub mortality data because no cubs were born to collared females, or collared mothers were lost from study (died or lost collar) before denning with yearlings.
[b] One bear that likely had cubs was not checked because access to her den was precluded by poor ice conditions.

Table 7. Intervals between surviving litters for black bears within 4 study sites in Minnesota (see Figure 1) through March 2018 (CNF since 1981, Camp Ripley since 1991, VNP since 1997, NW since 2007). Cubs are generally born in January and remain with their mother for about 17 months, so the normal reproductive interval is 2 years. Reproductive intervals here include only litters where at least 1 cub survived through the next denning period (1 year), so intervals <2 years are impossible.

Study area	2-year reproductive intervals	≥3-year reproductive intervals	% intervals ≥3 years
CNF	111	8[a]	7%
Camp Ripley	32	5	14%
VNP	15	1	6%
NW	18	0[b]	0%

[a] Including the only case of an interval spanning >3 years, due to whole litter loss followed by a non-reproductive year.
[b] Excluding 1 missed litter (3-year interval) that was due to the bear leaving the den after disturbance and aborting the litter.

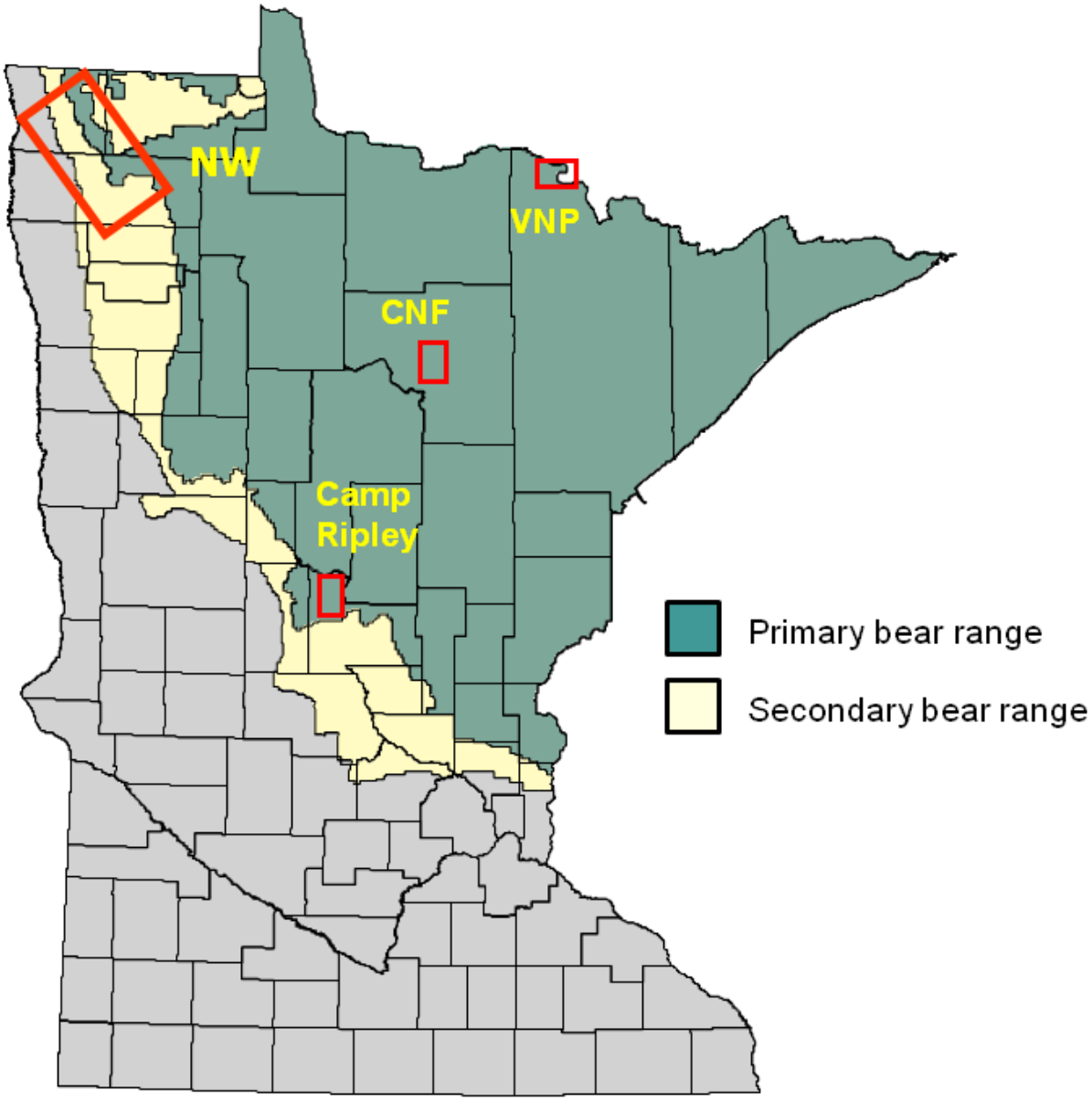

Figure 1. Location of 4 study sites within Minnesota's bear range: CNF (Chippewa National Forest, central bear range; 1981–2018); VNP (Voyageurs National Park, northern fringe of range; 1997–2018); Camp Ripley Military Reserve (near southern edge of range; 1991–2018); NW (northwestern fringe of range; 2007–2018).

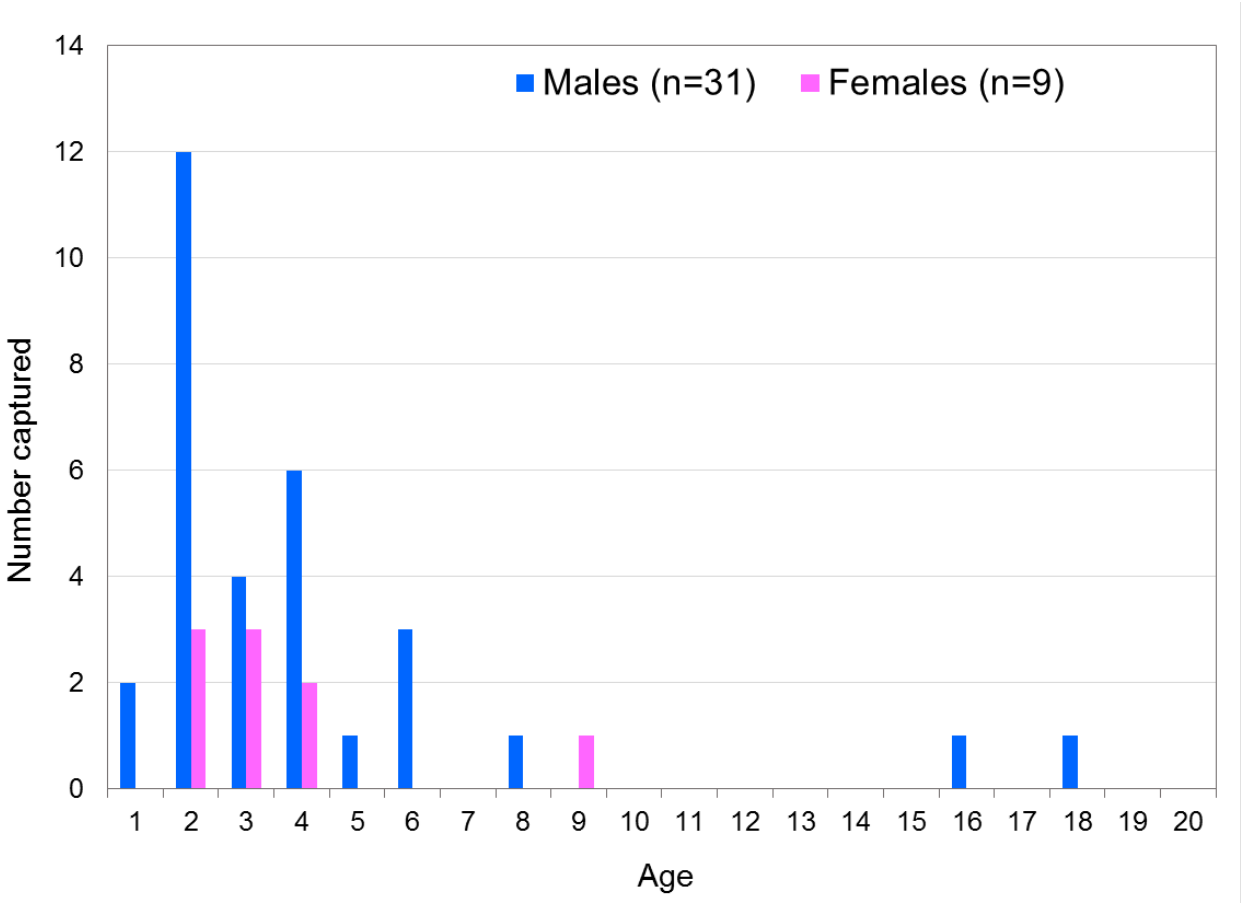

Figure 2. Bears captured by sex and age in the CNF, Minnesota, May−Aug, 2015–2017.

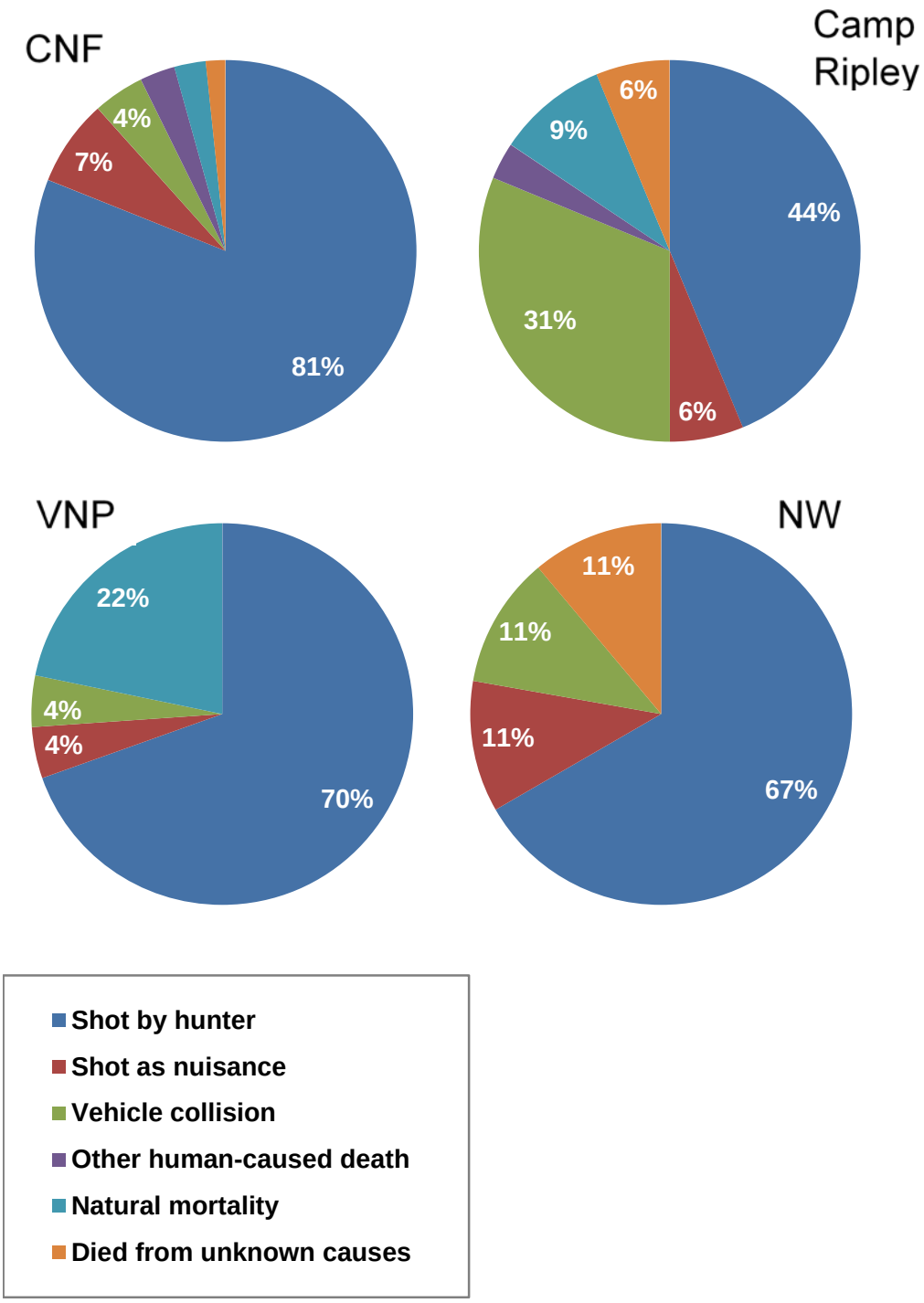

Figure 3. Proportional causes of death of radiocollared bears in each of 4 study sites in Minnesota. CNF expectedly had the highest proportion of bears killed by hunters because this is primarily public land that is heavily hunted. Camp Ripley and VNP are unhunted but bears are vulnerable when they leave on foraging forays. Hunters were asked not to shoot collared bears during the entire span of the NW study, so the proportion killed by hunters does not reflect the population at large. See map and dates for each study site in Figure 1.

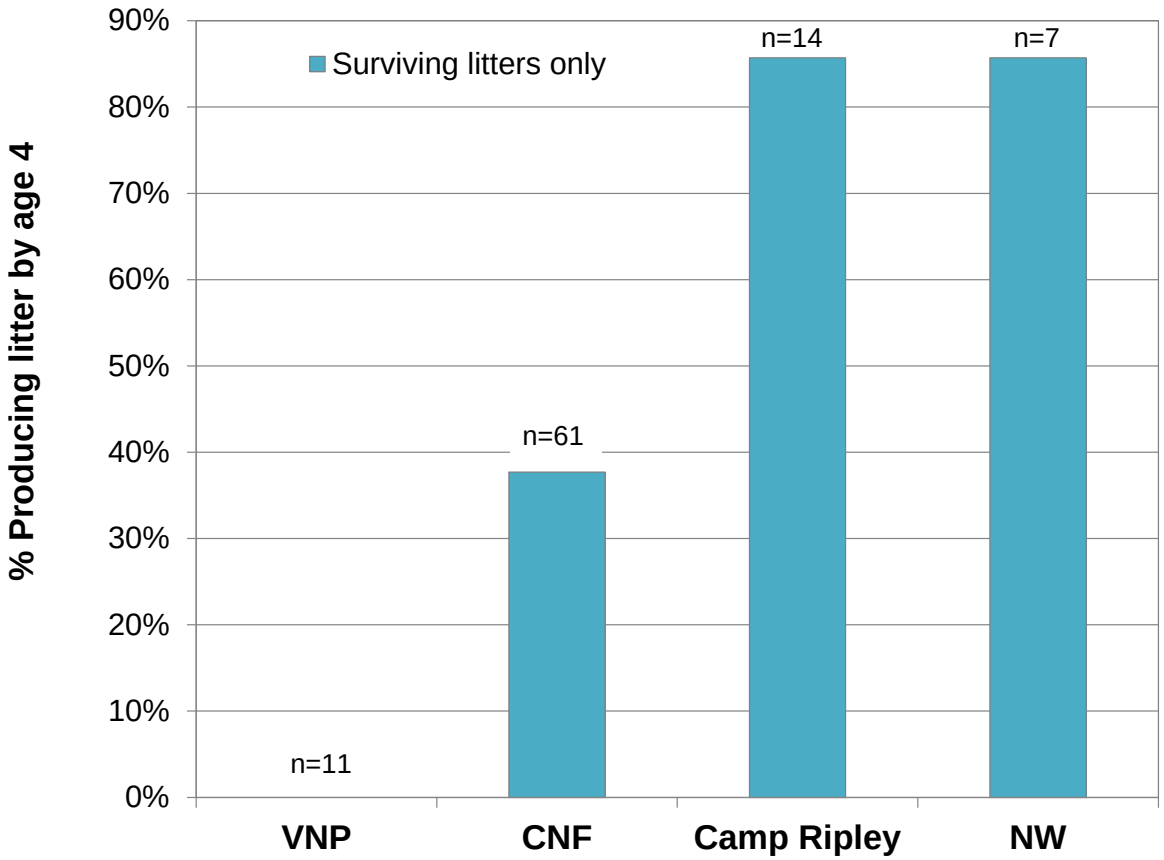

Figure 4. Percent of radiocollared female bears on each Minnesota study site that produced a surviving litter of cubs by 4 years old. Births of cubs were detected in natal dens in March each year (through March 2018). A surviving litter was one in which at least one yearling was present in the mother's den the next winter. Note that no females in VNP produced cubs by 4 years of age.

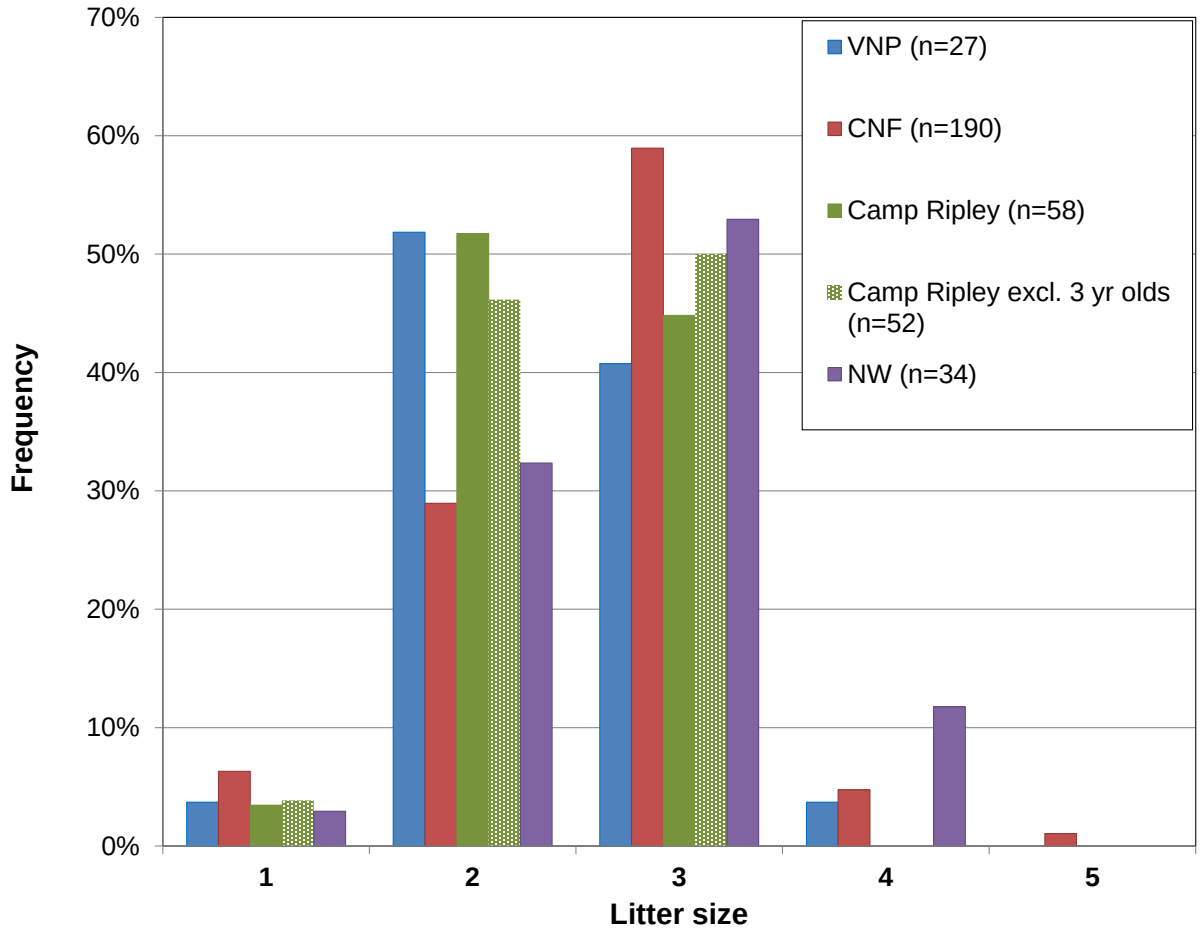

Figure 5. Frequency of cub litter sizes (examined in natal dens in March) within 4 Minnesota study sites (see Figure 1) through March 2018. Data include only litters that survived 1 year (even if some cubs in the litter died). Camp Ripley data are shown for mothers of all ages, as well as excluding 3-year-old mothers. For the other sites, elimination of 3-year-olds did not make a difference.

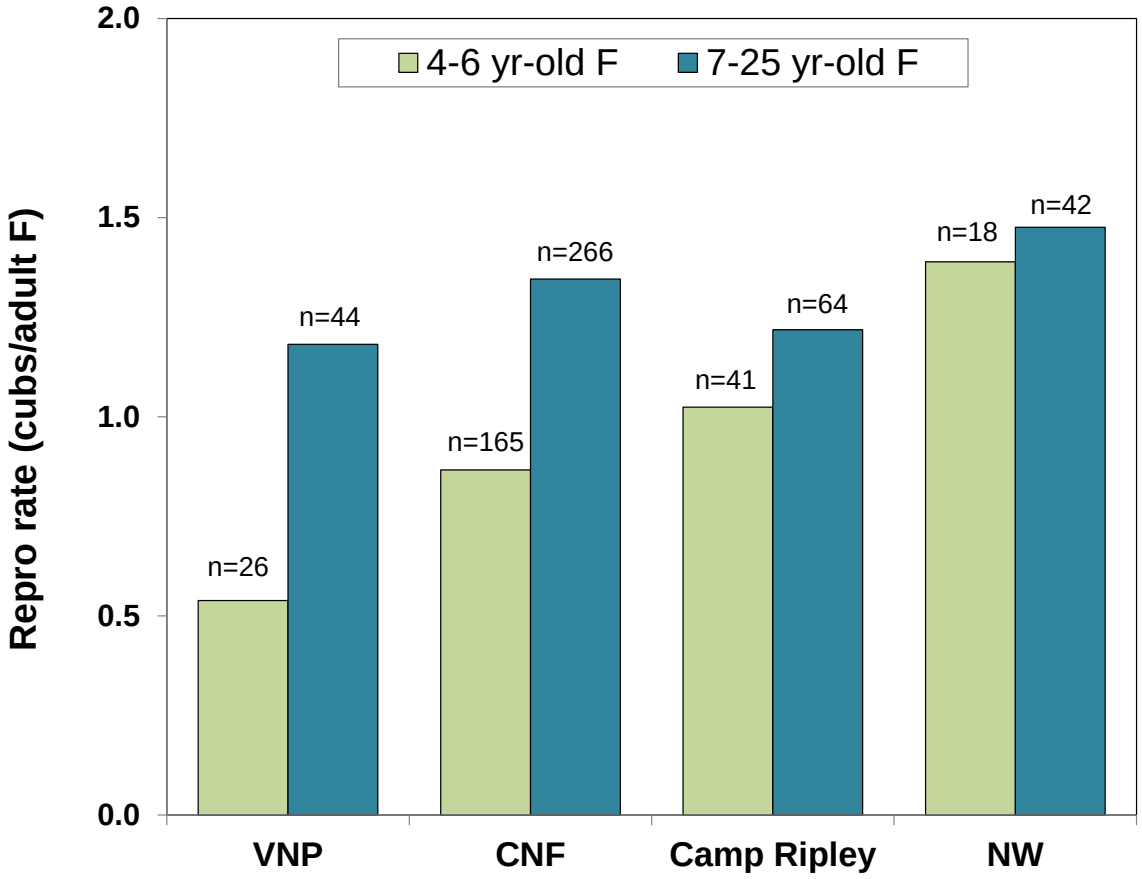

Figure 6. Reproductive rates of radiocollared bears within 4 Minnesota study sites (see Figure 1) through March 2018 (VNP since 1997, CNF since 1981, Camp Ripley since 1991, NW since 2007). Data include only litters that survived 1 year (even if some cubs in the litter died). Sample sizes refer to the number of female bear-years of monitoring in each area for each age group. Some bears in CNF, Camp Ripley, and NW produced cubs at 3 years old, but are not included here.

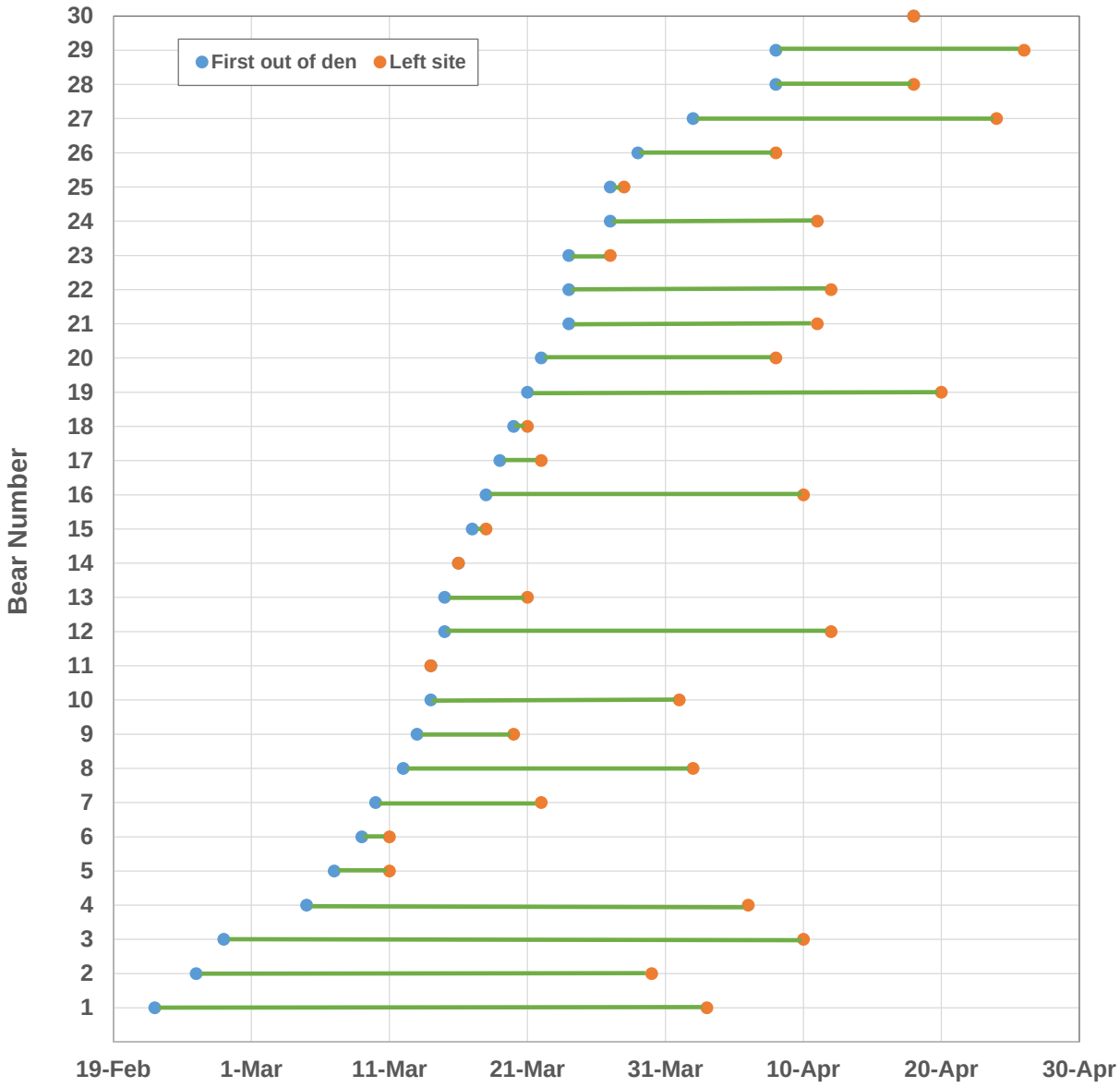

Figure 7. Dates of first emergence from dens, and eventual departure from the den site, for 30 radiocollared black bears monitored with remote cameras in Minnesota, 2015−2018. Cases are arranged in order of first emergence (blue dots). Green lines show the time period (0−42 days) that the bear remained at the den site following initial emergence. In 3 cases (bear 11,14, 30), the bear left the same day it emerged.

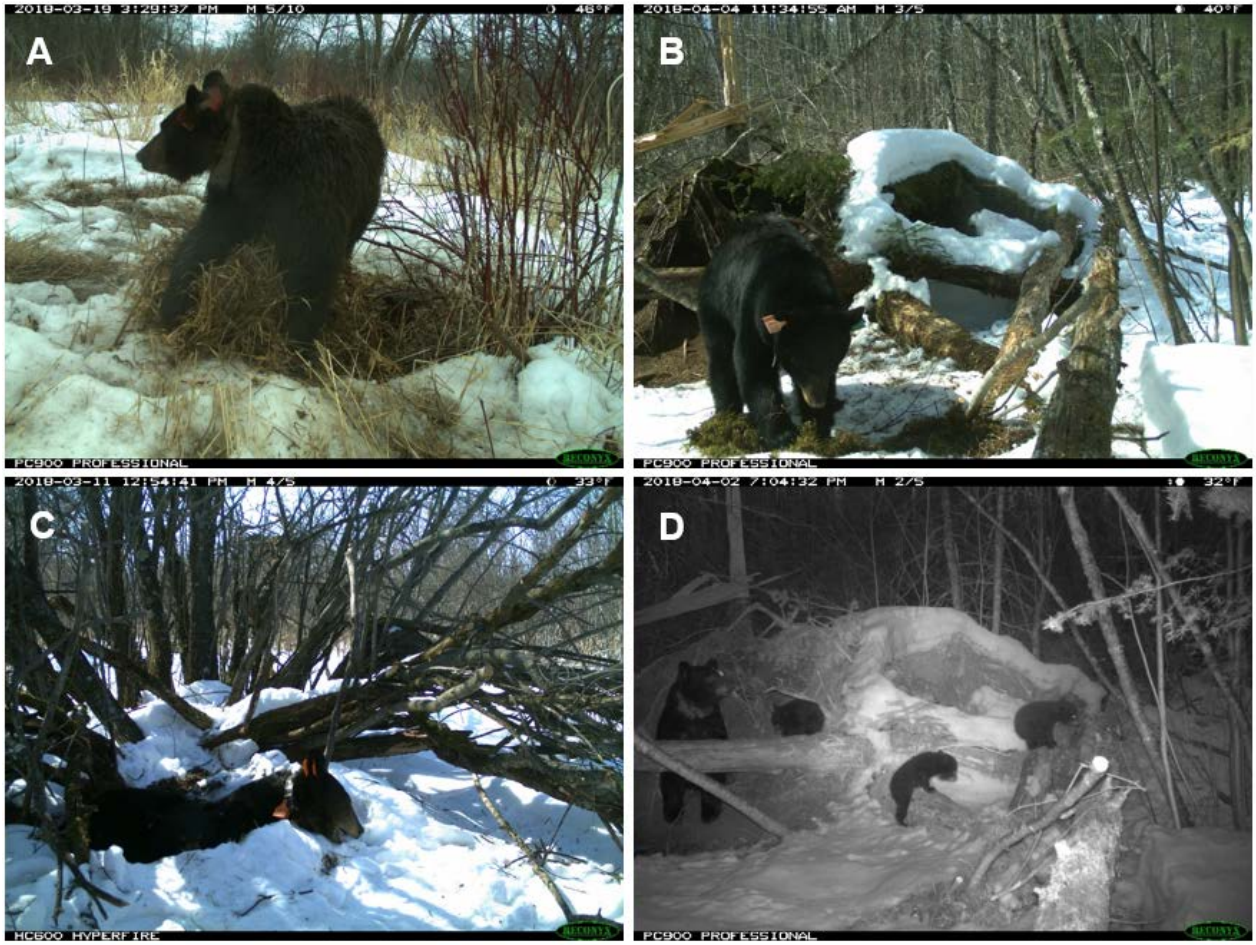

Figure 8. Camera-trap photos of activities around bear dens in Minnesota, March–April, 2018 (exact dates shown on photos), as bears emerged but did not yet leave the site. Common activities included: (panels A,B) raking in dry bedding material as melting snow leaked into their dens; (C) consuming snow; and (D) providing an opportunity for 2.5-month-old cubs to gain strength before abandoning the protection of the den site.

Figure 9. Camera trap photos (March 19–20, 2018) of a female bear in NW Minnesota (A) exiting an excavated den that flooded (note wet, matted hair). (B) She carried her wet cubs out of the den to a dry nest that she built outside the den. (C) This bear had a litter of 4 cubs, 3 of which survived (visible in nest). (D) The 4th cub died in the den and was carried out; its remains were found in the nest.

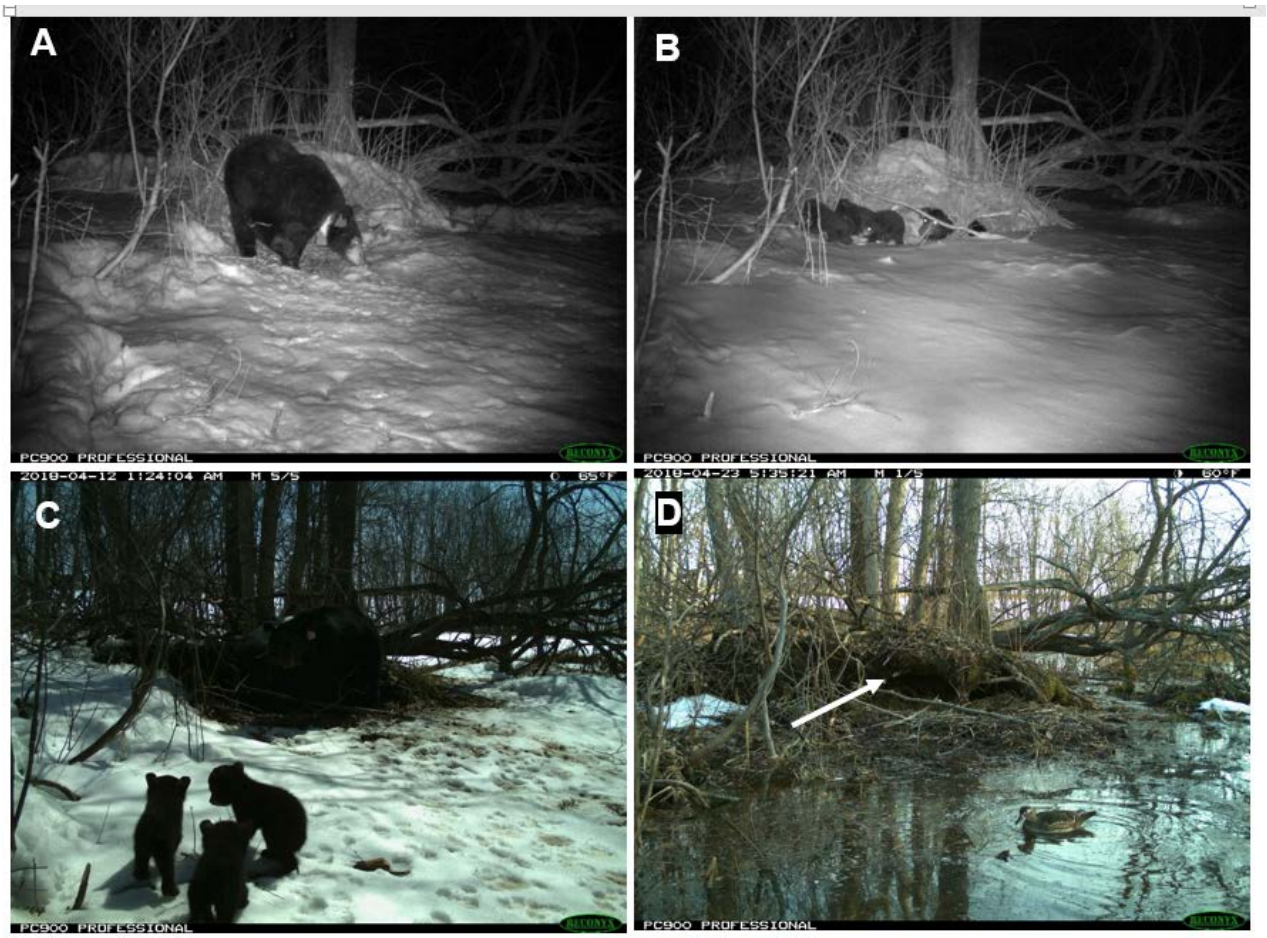

Figure 10. Camera trap photos of (A) a female bear in the CNF in Minnesota first emerging from her den on March 15, 2018; (B) the cubs emerging after a fresh snowfall; (C) the family leaving the densite on April 12 (note numerous tracks from the bears' frequent activities outside the den prior to leaving the site), and (D) 11 days later the site becoming a pond inhabited by a wood duck (den entrance shown by arrow). All photos are from the same camera position.