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Short-term fate of rehabilitated orphan black bears released in New Hampshire

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Abstract: We evaluated the release of rehabilitated, orphan black bears (*Ursus americanus)* in northern New Hampshire. Eleven bears (9 males, 2 females; 40–45 kg) were outfitted with GPS radio-collars and released during May and June of 2011 and 2012. Bears released in 2011 had higher apparent survival and were not observed or reported in any nuisance behavior, whereas no bears released in 2012 survived, and all were involved in minor nuisance behavior. Analysis of GPS locations indicated that bears in 2011 had access to and used abundant natural forages or habitat. Conversely, abundance of soft and hard mast was lower in 2012, suggesting that nuisance behavior, and consequently survival, was inversely related to availability of natural forage. Dispersal from the release site ranged from 3.4–73 km across both years, and no bear returned to the rehabilitation facility (117 km distance). Rehabilitation appears to be a valid method for addressing certain orphan bear issues in New Hampshire.

Key words: black bear, orphaned bears, rehabilitation, release, *Ursus americanus*

Orphaning of black bear cubs occurs through both natural and anthropogenic means, but most occurs directly or indirectly from human activities, including hunting, vehicular collision, and nuisance removals (Beecham 2006). Abandonment or separation may occur due to poor food conditions, weather, or den disruption (Clark et al. 2002, Beecham 2006). Rehabilitation of orphaned cubs involves captive care until their health allows for release, the timing of which varies (Beecham 2006). Releases usually occur the first summer or fall at 7–11 months of age (Erickson 1959, Skripova 2009), during winter in pre-constructed dens (Jonkel et al. 1980, Skripova 2009), or as yearlings in spring to early summer (Alt and Beecham 1984, Clark et al. 2002, Binks 2008). Success varies, but to enhance survival, it is recommended that orphaned cubs be released as yearlings to allow for sufficient weight gain and to coincide with the timing of natural family break-up when bears become biologically and socially self-sufficient (Alt and Beecham 1984, Beecham 2006, Binks 2008).

A major concern regarding rehabilitation is that cubs may habituate to humans and develop subsequent nuisance behavior after release (Jonkel et al. 1980, Beecham 2006, Binks 2008, Huber 2010). Although some rehabilitated bears have been involved in conflicts after release (Alt and Beecham 1984, Stiver et al. 1997), it does not always occur (Clark et al. 2002, Beecham 2006) and may be due to random, isolated incidents during dispersal (Binks 2008). Even in cases where some level of habituation develops during captivity, it does not necessarily persist after emergence from the winter den (Smeeton and Waters 2005; B. Kilham, personal observation). There is some evidence that limiting contact with humans and socializing with other bears may help minimize habituation (Beecham 2006). Furthermore, because some rehabilitated bears are involved in conflicts does not indicate that the likelihood of such is higher than for mother-reared cubs. The risk might be lower if rehabilitated cubs are in better physical condition than mother-reared cubs of the same age, or have learned how to

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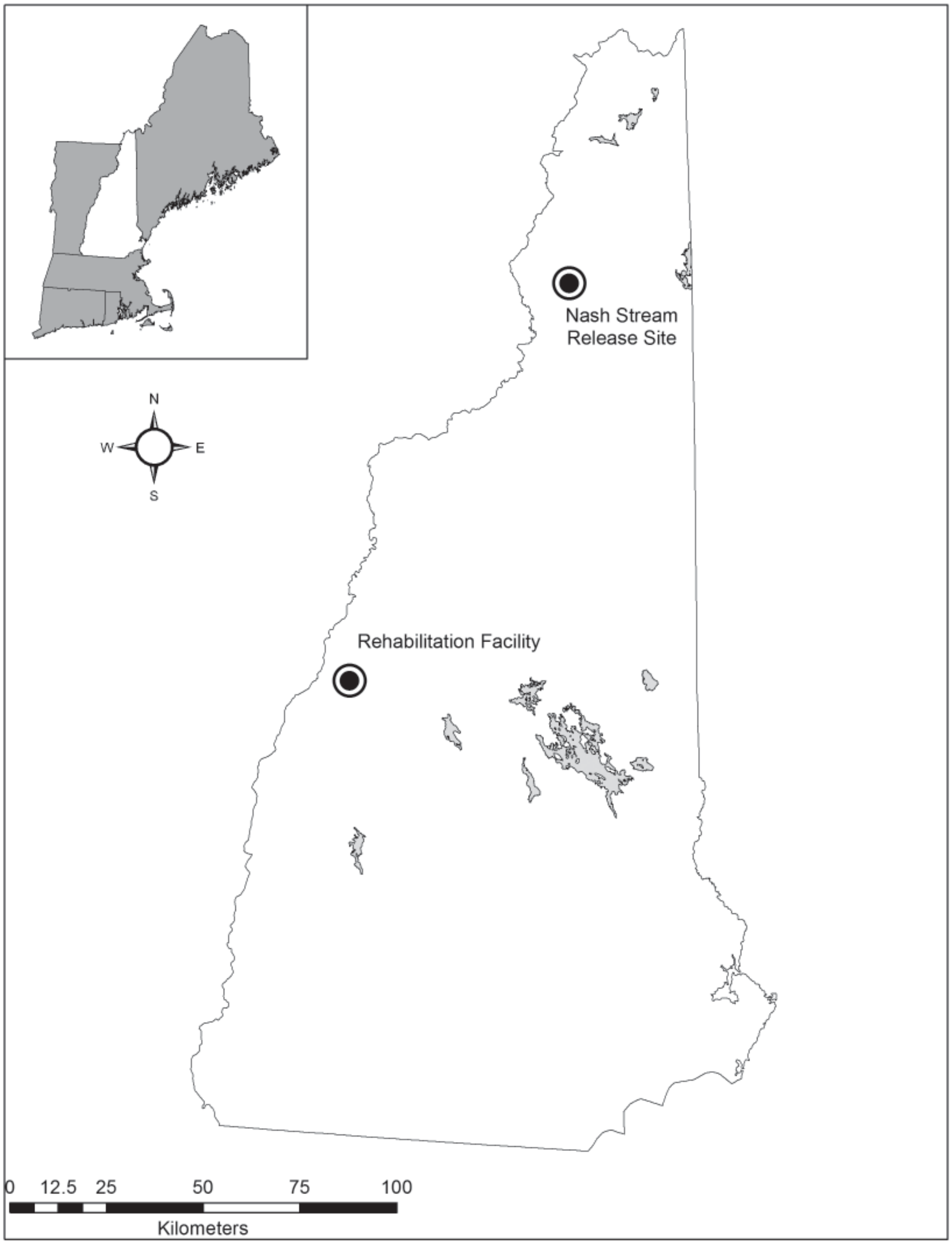

Figure 1. Locations of the rehabilitation facility (Lyme, NH) and release site for orphan black bears rehabilitated in New Hampshire; the distance between was 117 km.

cope with humans (Stringham 2002).

Despite the rehabilitation and release of orphan bears by numerous wildlife agencies in the northeastern United States and eastern Canada, studies regarding their survival and subsequent conflicts with humans are lacking. New Hampshire released 47 rehabilitated orphaned bears from 2000-2010. Although these animals were ear-tagged prior to release, little information was obtained regarding their fates. The purpose of this study was to determine the short-term (6 months) survival, dispersal, and conflict behavior of rehabilitated orphan black bears released in New Hampshire.

Study area

Rehabilitated bears were released in Nash Stream Forest, a 160-km^2 state-owned property in northern New Hampshire (Figure 1). The area is managed for recreation (including hunting), wildlife habitat, and sustainable timber harvest, which is representative of conditions throughout northern New Hampshire. Local bear density was estimated at 0.24/km^2 (NHFG 2012). The release site was ~10 km from the nearest residential area and paved road. The subsequent movement by released bears expanded the study area to include western Maine, northeastern Vermont, and southern Quebec. Elevations in the region range from 100–1,900 m. At low elevations, the forest is dominated by northern hardwoods including sugar maple (*Acer saccharum),* red maple *(A. rubrum),* American beech *(Fagus grandifolia),* and yellow birch *(Betula alleghaniensis).* Higher elevations are mostly red spruce *(Picea rubens)* and balsam fir *(Abies balsamea;* DeGraaf et al. 1992). Other common species include white pine (*Pinus strobus*) and eastern hemlock (*Tsuga canadensis*). Frequent commercial forest harvesting (DeGraaf et al. 1992) has created numerous openings dominated by early successional plants including raspberry and blackberry (*Rubus* spp.), pin cherry (*Prunus pensylvanica*), and aspen (*Populus* spp.). Riparian areas, including forested and open wetlands, ponds, lakes, rivers, and streams are interspersed throughout the region.

Methods

Rehabilitation and release

In New Hampshire, orphaned or abandoned cubs and injured or malnourished yearlings are taken to a state-licensed rehabilitator (B. Kilham, co-author) where they are held in captivity until ready for release (Figure 2). Bears are segregated by age class, with cubs (2–5 months) held in a 71-m^2 pen until they are moved in early summer to the primary holding facility, which is a 3.2-ha forested enclosure that includes a small pond, wetlands, large climbing trees, and a mosaic of tree/shrub species common to bear habitat in New Hampshire. To minimize habituation, human contact is limited to a single primary caregiver and, on rare occasions, with a secondary caregiver. Very young cubs are bottle fed until capable of consuming a mixed diet of fruits and wild vegetation (forbs, leaves, soft and hard mast), supplemented with dog food (approximately half of their human-supplied diet). Natural forage and insect larvae also exist within the enclosure. Bears are fed primarily by spreading food on the ground (as opposed to in bowls or troughs) to encourage natural foraging behavior. Bears overwintered at the facility in dens constructed by humans with natural materials, or by the bears. They are relocated and released the following spring to early summer as yearlings; malnourished or injured yearlings are released after attaining sufficient body mass and achieving self-sufficiency.

Rehabilitated bears at the facility were captured in spring 2011 (June 6–28) and 2012 (May 15–24) using culvert traps or dart guns and immobilized with Telazol (6 mg/kg body weight). Each was sexed, weighed, and fitted with a numbered metal tag in both ears and a GPS radio collar. Radio collars were ATS G2110D (Advanced Telemetry Systems, Isanti, Minnesota, USA) and Lotek GPS3300L (Lotek Wireless, Newmarket, Ontario, Canada), both store-on-board units equipped with VHF capability and mortality beacons. Collars were programmed to record a GPS fix every 2 hours and to drop off in early November. Bears were transported in culvert traps by truck and released at the same location in Nash Stream Forest, 117 km from the rehabilitation facility (Figure 1). As a general rule, it is in the months immediately after release that rehabilitated bears have their highest risks of mortality due to challenges with adjusting to the natural environment and avoiding conflict with humans (Alt and Beecham 1984, Beecham 2006). We expected the same to be true in our study and thus focused data collection on the months between release and denning the following winter.

Monitoring and collar retrieval

Ground and aerial telemetry were conducted bi-weekly and monthly, respectively, to monitor movement of bears after release. Mortality signals were investigated to verify mortality or determine if a collar had dropped. Collars from harvested or dispatched bears were retrieved or delivered to the New Hampshire Fish and Game Department (NHFG). Those that

Figure 2. Black bear cub at rehabilitation facility (left) and GPS radio collared yearling during release (right).

dropped off were collected from the field; those failing to release were retrieved via winter den visits. Ground and aerial telemetry locations, though limited, were used for analysis when a collar was irretrievable. Location data were downloaded from recovered collars and screened for accuracy by removing locations with dilution of precision (DOP) >5 (Lewis et al. 2007). Screened locations (for retrieved collars) and telemetry locations (for irretrievable collars) were then plotted and analyzed in ArcMap 10 (Environmental Systems Research Institute, Redlands, CA, USA).

Data analysis

Dispersal. The distance between the recovery location and the release site was measured for each bear; recovery locations included collar drop-off, den, or mortality site. In cases where the collar was not retrieved, recovery was defined as the last known point the collar was attached to the bear. A t-test was performed to test for difference ($P \leq 0.05$) in dispersal distance between years.

Nuisance behavior. Human–bear conflicts in New Hampshire have been jointly managed by NHFG and the U.S. Department of Agriculture Wildlife Services (WS) since 1996. Nuisance incidents are reported to NHFG regional offices or WS, with the latter maintaining a database of annual complaints. Reports of nuisance activity in neighboring jurisdictions were received from regional biologists from the respective state or province. We used reports of conflicts involving collared bears to gauge nuisance activity, with telemetry and knowledge of current locations used to identify individuals because tag numbers were not visible from a distance. Sightings unrelated to any conflict (e.g., a collared bear sighted crossing a road) were not considered a nuisance incident. Conflict events were not solicited from residents in order to reduce biased reporting of conflicts that would not otherwise result in complaints.

Mast production surveys

Mast assessments were conducted by agency wildlife biologists and foresters on 10 of the most widely distributed fruit-producing species commonly consumed by black bears in New Hampshire, including blueberry (*Vaccinium* spp.), blackberry and raspberry, choke cherry (*Prunus virginiana*), American cherry (*Prunus serotina*), American mountain ash (*Sorbus americana),* apple (*Malus* spp.), beaked hazel (*Corylus cornuta*), American beech, and oak (*Quercus* spp.). Survey participants assessed mast production for each species at ≥2 locations within a wildlife management unit (WMU; state is divided into 18 units), timed to coincide with the period of peak maturity for fruit. Mast production was qualitatively ranked on a scale of 1 (poor) to 10 (excellent) and a species-specific mean production score was calculated for each WMU. Scores from WMU B (where the release site was located) were used for analysis.

Table 1. Release, conflict, and recovery information for rehabilitated orphan black bears released as yearlings in Nash Stream Forest, NH, June 2011 and May 2012.

Release date	Bear ID	Sex	Days in rehabilitation	Estimated release weight (kg)	Recovery distance (km)	Mortality
6/6/2011	R138*	Male	52	33	18.8	
6/6/2011	R140	Male	183	41	6.5	
6/6/2011	R143	Male	46	32	6.0	Harvest
6/6/2011	R145	Male	390	45	8.6	
6/21/2011	R132	Female	383	45	5.2	
6/21/2011	R134	Male	383	59	10.0	
6/28/2011	R126	Male	74	41	3.4	
5/15/2012	R286	Male	348	45	73.1	Conflict
5/21/2012	R283	Male	362	45	7.4	Poached
5/21/2012	R297**	Female	285	32	8.3	
5/24/2012	R288	Male	354	54	20.1	Harvest

*VHF signal malfunction; only telemetry locations available.
**Slipped collar <2 weeks after release.

Results

Eleven cubs (9 males, 2 females) were rehabilitated and released as yearlings in Nash Stream Forest (Table 1): 7 (6 males, 1 female) in 2011 (June 6–28) and 4 (3 males, 1 female) in 2012 (May 15–24). The estimated weight of all ranged from 32–59 kg. Collars were recovered from 10 cubs (8 males, 2 females), with 12 telemetry locations collected for 1 collar that was not retrieved due to VHF signal malfunction. A female in 2012 slipped its collar <2 weeks after release and was not included in any analysis, reducing the 2012 study population size to 3 bears. All bears (10/10) survived through the first 30 days, and 6 of 10 bears survived through the end of the next New Hampshire hunting season (6 of 7 in 2011 and 0 of 3 in 2012). All mortality was human-induced: 2 hunter harvests and 1 illegal kill in New Hampshire, and 1 landowner-dispatched bear in Quebec. One female released in 2011 was harvested during the 2012 hunting season in adjacent Vermont; it was 59 km from the release site and 55 km from the recovery site.

Dispersal

The mean recovery distance from the release site for all bears was 15.9 ± 19.8 (SD) km, with bears in 2011 (8.4 ± 2.2 km; range = 3.4–73.1 km) recovered ~25 km closer to the release site than bears in 2012 (33.5 ± 28.5 km; range = 7.4–73.1 km)—a non-significant difference (t_2 = 1.25, P = 0.34). No bear returned to the rehabilitation facility. There were no obvious trends in dispersal direction, though the small size of the study population likely prevented the detection of any pattern.

Nuisance behavior

There were no nuisance reports associated with bears released in 2011, whereas all 3 bears released during 2012 were presumably in conflict situations in that same year. Male R288 raided a birdfeeder 10 km from the release site in early June; this activity ceased after removal of the attractant with the bear remaining in that area for 2 months. The collar of male R283 was cut and found in the Connecticut River in early July. Investigations by NHFG indicated the bear was killed by a landowner for reportedly approaching livestock. Male R286 was killed by a homeowner in early October after a bear, possibly this one, damaged bee hives near Sherbrooke, Quebec, 73 km from the release site.

Mast production surveys

Mast production scores in WMU B were higher in 2011 than 2012 for all surveyed species except oak, which received the same score in both years (Figure 3). In 2011, 8 of 10 species received scores >5, with American cherry and oak scoring 3.5 and 3, respectively. Only blueberry scored >5 in 2012.

Discussion

Survival

The average weight of released cubs (approximately 43 kg) was about twice that of typical yearlings in New Hampshire (20.5 kg; NHFG unpublished data) and Montana (22.3 kg; Jonkel and Cowan 1971). The cubs' excellent body conditions may have contributed to the high survival during the first month by providing a buffer of energy and time during the acclimation period. Subsequent mortality was all human-induced, which was expected given that humans are responsible for most mortality of subadult black bears (especially males) continent-wide (Bunnell and Tait 1985, Schwartz and Franzmann 1992, Beringer et al. 1998, Lee and Vaughan 2005), including rehabilitated yearlings in Ontario (Binks 2008). The same was true in New Hampshire, as yearling females and males comprised 16% (n = 91) and 28% (n = 187) of the total bear harvest in 2011–2012 (NHFG unpublished data). Given that rehabilitated bears are released with the intention of becoming functioning members of a harvestable bear population, the fact that some are killed by vehicles or by sport hunters is not seen as a problem by the NHFG, so long as they are not unusually susceptible to these hazards. The overall survival (6 of 10) achieved during the 6-month post-release period indicated that most released bears were not overly susceptible to mortality, including hunter harvest during the first fall. The mean estimated harvest rate of male bears in New Hampshire during 2011–2012 was 24% (NHFG 2012, 2013), similar to the harvest rate of males in our study (2 of 9).

The apparent difference in survival between years could be attributed to differential availability of natural forage. Surveys indicated high mast abundance (i.e., raspberries, blackberries, beechnuts) in the release area during 2011, but low abundance during 2012 (Figure 3; NHFG 2012, 2013). Throughout the state, mast production in 2012 was a failure for nearly all surveyed species as production scores were the lowest they had been in 8 years (A. Timmins, unpublished data). When natural forage is limited, bears seeking alternate food sources are often associated with higher conflict rate, hunting mortality, lethal management action, and illegal killing (Rogers 1976, Knight et al. 1988, Noyce and Garshelis 1997, Baruch-Mordo et al. 2008). The longer dispersal and movements, and increased use of human-associated areas (indicated by greater conflict rate) by bears released in 2012 apparently elevated their susceptibility to harvest and other forms of mortality that year, as has also been documented in other populations (Beeman and Pelton 1980, Bunnell and Tait 1985, Kane 1989, Kasbohm et al. 1994).

Dispersal

Rehabilitated bears were released at an age and time that coincided with the timing of natural family breakup, as black bears generally disperse from their natal ranges as yearlings during early summer (Jonkel and Cowan 1971, Clevenger and Pelton 1990, Schwartz and Franzmann 1992). Subadult males generally disperse greater distances as compared to other age and sex classes (Rogers 1987, Schwartz and Franzmann 1992, Lee and Vaughan 2003). Rehabilitated bears were predominantly male in both years of the study, but dispersal distance was greater in 2012 than 2011. This suggests other factors besides sex and age influenced dispersal in each year. It is likely that the difference in availability of natural forage affected dispersal each year. Several important summer and fall foods (mainly mast) were more abundant in 2011 than 2012 (Figure 3). For example, in 2011, blackberry, choke cherry, beech, and mountain ash mast were highly abundant during late summer and fall (Figure 3) and likely reduced movement relative to 2012. Likewise, during 2011, bear locations were more geospatially concentrated in and around regenerating cuts (characteristic of soft mast species; Smith 2013). All recovered collars in 2011 (except 1 mortality) were located on ridges or mountain tops with abundant beech and mountain ash near (≤10 km) the release site. In contrast, in 2012, scarcity of raspberry and blackberry likely induced longer movements, as has been observed in other populations during poor food years (Beeman and Pelton 1980, Garshelis and Pelton 1981, Noyce and Garshelis 1997). While bears in 2012 were released several weeks earlier than those in 2011, the timing of both releases was similar

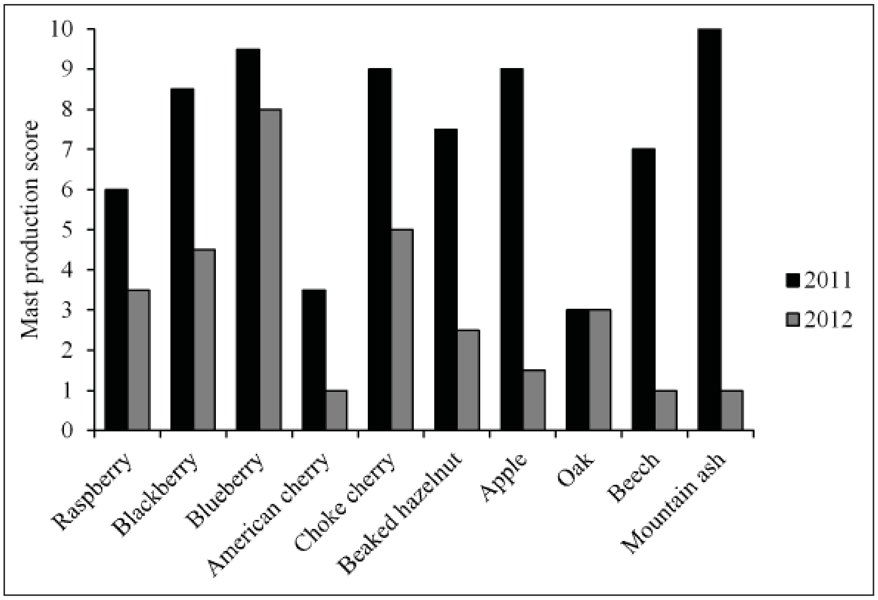

Figure 3. Mast production scores for 10 hard and soft mast species in Wildlife Management Unit B (where the release site was located), New Hampshire, 2011–2012 (NHFG 2012, 2013). Mast assessments were conducted by NHFG staff during July to October of each year, ranking mast production on a subjective scale of 1 (poor) to 10 (excellent).

in relation to spring phenology (i.e., spring green up) and occurred prior to the emergence of summer berry crops.

Increased dispersal in 2012 was not restricted to only bears released that year. Female R132 released in 2011 was harvested 59 km from the release site during October 2012. This bear exhibited very restricted movement in 2011, concentrating activity in areas of abundant blueberry, beech, and mountain ash. The reduced availability of these mast crops in 2012, notably of beech and mountain ash (Figure 3), may have caused R132 to disperse out of the release area in search of more productive areas.

It is possible that bears released in 2011 remained in the release area and reduced available space for the 2012 cohort, thus increasing their post-release movements. However, the short duration that bears were collared in our study limits knowledge of movements beyond 6 months post-release. A similar trend may have occurred due to a change in density of wild bears within the study area, though bear abundance was considered stable in that area (NHFG 2013).

Nuisance behavior

The difference in available forage between years was also likely responsible for the absence of nuisance reports on yearlings released in 2011 versus nuisance reports on all 3 released in 2012. The difference in nuisance behavior reflected the record number (1,108) of conflicts statewide in 2012, 117% higher than those reported in 2011 and 78% higher than the preceding 10-year average (NHFG 2013). However,the conflicts involving study bears were relatively minor and did not require major management action (e.g., removal) based on New Hampshire's nuisance bear policy. All could have been avoided had landowners adhered to the standard bear conflict mitigation practices recommended by most jurisdictions. These practices were designed to deny bears access to food (e.g., remove birdfeeders, place electric fencing around apiaries and livestock pens).

For example, male R288 pilfered a birdfeeder in early June, but ceased after the feeder was removed. NHFG urges landowners to remove feeders after March 31 to avoid such conflicts. Location data showed subsequent activity by R288 in adjacent wetlands and clear-cuts, suggesting that removal of the attractant and emergence of summer forage effectively negated this bear's nuisance behavior. Binks (2008) also observed such opportunistic behavior by rehabilitated bears in Ontario, and attributed it to incidental contact during dispersal. This activity is characteristic of normal foraging behavior as bears are adept at finding and utilizing concentrations of highly nutritious foods (McCullough 1982, Bacon and Burghardt 1983, Eagle and Pelton 1983). Conflicts are inevitable when anthropogenic food sources are readily available or poorly secured, especially when natural forage is limited (Figure 3).

Despite a partial diet of dog food during rehabilitation, the bears did not exhibit signs of excessive food-conditioning or habituation, such as home entry or obvious lack of fear of humans—behaviors that would likely be reported to NHFG and USDA WS. Use of anthropogenic food during rehabilitation does not necessarily lead to dependence on such food or related search behaviors in human-dominated areas, or predispose the animal to conflict activity. Furthermore, conflict reports in New Hampshire rarely involve pet food as an attractant (0 of 1,618 bear complaints in 2011–2012 listed pet food as the attractant; NHFG 2012, 2013).

When evaluating nuisance behavior in rehabilitated bears, it is important to distinguish between random, isolated incidents and chronic nuisance activity resulting from extreme habituation. The former is a product of normal foraging behavior and is contingent primarily upon the availability of natural and anthropogenic food; the latter could be a result of food rewards or the rehabilitation process. Human–bear conflicts are not uncommon in landscapes like New Hampshire where human development and associated anthropogenic food sources abut large tracts of contiguous forest (Comeau 2012); however, few bears are considered food-conditioned or highly habituated. If the objective of rehabilitation is to release a bear that is similar to its wild counterpart (Binks 2008), it would be inappropriate to label rehabilitation a failure if some engage in minor nuisance activity. Although rehabilitation likely leads to some habituation or at least tolerance of human presence (Beecham 2006), it does not correlate with the development of chronic nuisance behavior by rehabilitated bears. Binks (2008) found few occurrences of nuisance behavior in bears rehabilitated with varying degrees of human contact. However, if rehabilitated bears show excessive levels of conflict behavior or lack of fear toward humans, possibly related to habituation (e.g., persistent nuisance behavior, panhandling, home entry) an assessment of the rehabilitation program is probably warranted. This assessment should also consider other factors that may explain an increase in conflict behavior, including mast crop failures, the availability and accessibility of anthropogenic attractants, relative body size, injury, population density, and human activity and density near the release area.

Management implications

Overall, the high short-term survival and limited nuisance activity measured in this study indicates that rehabilitating orphan black bears is a viable technique as conducted in New Hampshire. However, rates of both survival and conflicts were apparently influenced by the relative availability of natural forage as bears exhibited high survival, low movement, and little nuisance activity during a good food year (2011), with the opposite largely occurring during a poor food year (2012). There was no evidence of excessive habituation or unacceptable nuisance activity, suggesting that current techniques are effective at minimizing a rehabilitated bear's association with humans.

Given the small population and short duration of this study, extended research on more cubs is recommended to better assess long-term movement, survival, and behavior of rehabilitated bears. Despite the promising results of rehabilitation in New Hampshire, the technique should remain a secondary option when addressing orphan bear issues. Currently, orphan bears are given the opportunity to survive on their own before any action is taken, and only bears that require immediate human intervention are considered candidates for rehabilitation. The current policy should remain as such to avoid elevating public expectations and burdening an effective rehabilitation program.

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