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FEATURES OF THE BROWN BEAR (*URSUS ARCTOS*) SEASONAL ACTIVITY IN THE BEREZINSKY BIOSPHERE RESERVE

The data on the seasonal activity and phenology of its main stages of the brown bear (*Ursus arctos* Linnaeus, 1758) in 2022—2024 were collected in the Berezinsky Biosphere Reserve, which is located in the northern part of Belarus and covers an area of 86,100 hectares. Forests occupy 89 % of its territory and belong to the subtaiga broadleaf-spruce forest subzone. The primary investigation methods were year-round palmar callus mapping, with individual bear identification whenever possible, and use of camera traps.

The average annual date for males to leave their dens is March 16, and for females — April 5. The mating season lasts from late April to the second half of June, lasting up to 2 months. Denning occurs in late November — early December. Females with yearling cubs den earlier than other age and sex groups.

During the wakefulness period, brown bears exhibit a pronounced unimodal seasonal activity pattern. Its peak is recorded in May, during the mating season. In March and April, after awakening, activity increases. High activity in April is associated with preparation for mating, active movements and marking behavior of males. By June activity stabilizes, then gradually decreases by the end of November. The brown bear's period of wakefulness can be divided into three stages: post-denning, mating, and fattening. During the post-denning period, bears are inactive; only closer to the mating season males begin active marking. The mating season is characterized by the highest activity of brown bears, when breeding adult individuals move a lot. The fattening period (hyperphagia) is of low physical activity with minor fluctuations, associated with changes in feeding areas. No significant differences in seasonal activity are observed between males and females.

Key words: brown bear; *Ursus arctos*; Berezinsky Biosphere Reserve; Specially Protected Natural Area (SPNA); phenology; seasonal activity; Red Data Book.

Fig. 3. Tabl. 2. Ref.: 18 titles.

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ОСОБЕННОСТИ СЕЗОННОЙ АКТИВНОСТИ БУРОГО МЕДВЕДЯ (*URSUS ARCTOS*) В БЕРЕЗИНСКОМ БИОСФЕРНОМ ЗАПОВЕДНИКЕ

Материал по сезонной активности и фенологии ее основных этапов бурого медведя (*Ursus arctos* Linnaeus, 1758) собирался в Березинском биосферном заповеднике в 2020—2024 годах, который расположен в северной части Беларуси на площади 86,1 тыс. га. Леса занимают 89 % его территории и относятся к подзоне подтаежных широколиственно-еловых лесов. Материал собирался методами круглогодичного картирования отпечатков пальмарной мозоли по возможности с индивидуальным распознаванием особей медведя и с использованием фотоловушек.

Среднегодовая дата покидания самцами берложных места — 16 марта, у самок — 5 апреля. Брачный период длится с конца апреля по вторую половину июня, продолжается до двух месяцев. Залегание в берлогу происходит в конце ноября — начале декабря. При этом самки с медвежатами-сеголетками залегают в берлогу раньше других половозрастных групп.

В период бодрствования медведь имеет ярко выраженную унимодальную сезонную активность. Ее пик регистрируется в мае, в брачный период. В марте—апреле, после пробуждения, активность растет, высокая активность медведя в апреле связана с подготовкой к спариванию, активными перемещениями и маркировочным поведением самцов. К июню активность стабилизируется и постепенно снижается к концу ноября. Период бодрствования медведя можно разделить на три этапа: постберложный, брачный и нажировочный. В постберложный период медведи мало активны, лишь ближе к брачному периоду самцы активно начинают вести маркировочную деятельность. В брачный период активность наивысшая, взрослые размножающиеся особи активно перемещаются. Нажировочный (гиперфагия) период характеризуется невысокой двигательной активностью, незначительные флуктуации уровня активности связаны со сменой кормовых станций. Существенных различий между самцами и самками в сезонной активности не наблюдается.

Ключевые слова: бурый медведь; *Ursus arctos*; Березинский биосферный заповедник; особо охраняемые природные территории; фенология; сезонная активность; Красная книга.

Рис. 3. Табл. 2. Библиогр.: 18 назв.

Introduction. The seasonal activity patterns of animals are determined by their physiological characteristics and environmental factors. *Ursus arctos* Linnaeus, 1758 (here in after referred to as the brown bear) is a species of carnivorous mammal native to Belarus with pronounced seasonal activity throughout its range. In the Berezinsky Biosphere Reserve (here in after referred to as BBR), located in northern Belarus, winter is characterized by low temperatures and, normally, constant snow cover (excluding short thaw periods). Therefore bears are inactive during winter; they hibernate, which occupies a significant part of the species' annual cycle. The warm season, when the predator is active, is clearly divided into several seasonal periods, the duration of which depends on a number of factors: vegetation abundance and food supply, social factors during the rutting season, climatic conditions, etc [1].

Available data on the phenology of this species in the local literature primarily date back to the last century and are rather general and descriptive [2—7].

The Berezinsky Biosphere Reserve and its surrounding areas are home to the largest brown bear population in Belarus, numbering approximately 90 individuals. The species density here reaches 1 individual per 1,000 hectares of suitable territory — a high number typical only for protected and unexploited populations [8]. The brown bear is a protected species and is listed in the Red Data Book of the Republic of Belarus [9], but at the same time, hunting for it has been permitted in some regions of Belarus since 2025. So present-day data on the phenology and seasonal activity of the brown bear are essential for the environmentally sound conservation and management of this species.

The aim of this study is to investigate the seasonal activity and phenology of its main stages of the brown bear in the Berezinsky Biosphere Reserve. The objectives of the study are (1) to determine the main stages of phenology of the seasonal activity of brown bear in the conditions of the BBR, (2) to identify seasonal cycles that differ in the characteristics of its activity, and (3) to determine, if possible, the factors that determine this seasonal cyclicity.

Materials and methods. *Study area.* All work was carried out on the territory of the Berezinsky Biosphere Reserve and the adjacent territories of the “Barsuki” and “Berezino” hunting grounds (Figure 1). The reserve is located in the northern part of Belarus within the following geographic coordinates: 54°28'—54°58' N and 28°08'—28°33' E. The total area of the reserve is 86.1 thousand ha. Of this, 89.1 %, or 76 thousand hectares, is covered by forest, including 86.6 % of natural forest. Non-forested lands make up 1.4 % (burnt areas, clearings, clearings, and wastelands), and 9.8 % are occupied by open marshes and water bodies. The Berezinsky Biosphere Reserve is located in the subtaiga broadleaf-spruce forest subzone of the Eurasian taiga zone. More detailed description of natural and climatic conditions is given in other sources [10; 11].

Data collection. The study utilized data collected between 2020 and 2024 using several methods. The first was year-round mapping of bears palmar callus prints. Using this method, we regularly measured the width and length of bear forepaw prints, entering the data into the QField mobile app [12], either during annual animal censuses or in conjunction with other work.

Determining age and sex characteristics based on print size and shape was performed according to a number of recommendations [1; 13; 14], taking into account indirect indicators. Bear tracks were recorded on readily detectable soils: wet areas, sandy roads, mud, plowed firebreaks, oat and corn fields, etc.

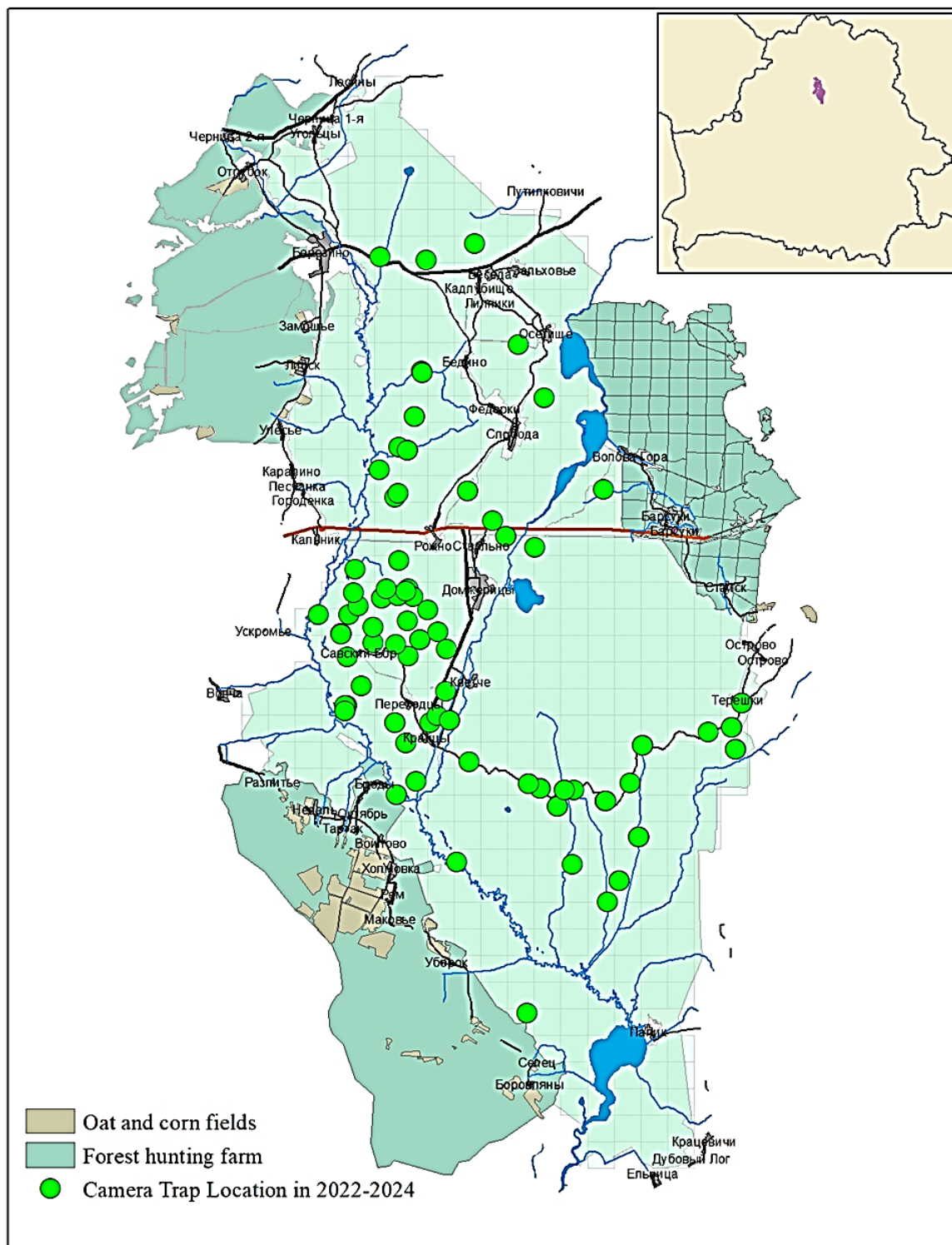


Figure 1. — Research area: the Berezinsky Biosphere Reserve and adjacent areas

Рисунок 1. — Территория исследования: Березинский биосферный заповедник и прилегающие территории

In this study, we used camera trap data collected between 2022 and 2024. The following models of camera traps were used: Seelock S128, Seelock S328, Seelock S308, BolyGuard SG520, ScoutGuard 2060-K, Suntek HC 810A, and Cuddeback G-5031. All cameras were equipped with IR illumination. The camera traps were mounted on tree trunks at a height of 0.8—1.8 m with the northern, northeastern, or northwestern exposure. The camera traps were active 24 hours a day. During the active vegetative season, the area in front of the camera trap was cleared of tall grass and shrubs. Natural or artificial bait was not used. Two investigation patterns were used in the study. The first, random design was based on locations with the highest number of bear detections: at quarter lines intersections, road junctions, winter paths, watering holes, bridges, marsh islands, grooming and resting areas, etc. After an unspecified period of time, some camera traps were deliberately relocated. The following settings were set on the camera traps: shooting mode — photo, number of frames — 1 to 5, shooting interval — no interval, sensitivity — medium. Some cameras had a shooting mode: photo + video. Beginning from April 2024, we implemented an additional study pattern — a systematic placement of cameras at random intervals, based on a grid with 1 location per 2 km² square. All camera traps operated in photo mode, no interval, number of frames — 3—5, sensitivity — medium.

In addition to the primary survey methods described above, we used a survey method and questionnaires among the reserve's forest guards and local residents. These methods do not yield precise data or specific numbers, yet provide only superficial information that requires subsequent verification.

During this study, conducted from 2020 to 2024, 317 bears palmar callus prints were found and measured. Approximately 38 % of the prints belonged to males, 16 % to single females, 11 % to females with young of the year, 15 % to juveniles, and 19 % to unidentified individuals.

Between 2022 and 2024, camera traps operated 10,192 trap nights (TN). In total, they were located at 52 locations. A total of 533 independent detections of brown bear (Trap Events, TE) were recorded.

Data analysis. Primary processing and tagging camera trap photographs was performed using Timelapse program [15]. Further processing, analysis, and visualization were performed using RStudio 2023.06.1 based on R 4.5.0 [16]. R code was partially taken from this source [17]. A time interval of 30 min was chosen for dividing registrations into independent ones, in accordance with the latest recommendations [17]. The Relative Abundance Index (RAI) was calculated as the ratio of the number of independent detections (Trap Events, TE) to the number of camera trap nights (TN) worked, multiplied by 100 [17].

The camera trap activity by year is presented in table 1.

Results and discussion. The brown bear's annual cycle is divided into two periods: hibernation and wakefulness. The latter can be further subdivided into stages. Various researchers typically identify between two and four distinct stages [1]. Based on our data, wakefulness should be divided into three periods: post-denning (early spring), mating, and fattening (hyperphagia). Each of these periods is characterized by its own level of activity depending on physiological needs and climatic factors.

Т а б л е 1. — Brown bear (*Ursus arctos*) capture rates using camera traps in the Berezinsky Biosphere Reserve in 2022—2024

Т а б л и ц а 1. — Показатели фиксации бурого медведя (*Ursus arctos*) при помощи фотоловушек в 2022—2024 годах в Березинском биосферном заповеднике

Capture rates	2022	2023	2024
TN	1,936	2,738	5,518
TE	103	156	274
RAI	3,45	3,62	3,61

Determining the exact spring awakening of brown bears and their leaving dens is quite difficult. The main reason is that after awakening, bears initially do not wander far from their denning sites and search for food nearby, returning to their dens to rest [1], which reduces the chance of recording the species. We investigated that males are the first to awaken and leave their dens. This occurs in the second half of March, the long-term average dates — March 16 (Table 2). According to literary sources and our own data, females with yearlings are the last to leave the den sites. The first spring registrations of females with yearlings occur in the first ten days of April, the long-term average date is April 5. The timing of awakening mostly coincides with those previously described in literature [2; 3; 6; 7]. It is worth noting that even in years with early spring, when the snow melts at the beginning of March, bears continue to remain in the dens until the above-mentioned dates. In 2024, the snow cover melted at the end of February, but the majority of individuals continued to remain in the dens until April. Therefore, it can be assumed that the absence of snow cover is not a decisive factor in bears leaving their dens.

The mating season of brown bears begins in late April or early May and ends in the second half of June. It lasts up to two months. The earliest registrations of a mating pair occurred in late April and were recorded by a camera trap on April 29, 2023 and April 30, 2023. A female with one second-year bear cub was also recorded by a camera trap on April 27, 2024, but a few days later, the cub was seen alone. Apparently, the female was ready to mate, and she has driven the cub away; subsequently, it was recorded alone several times. The latest registration was in June 20, 2022. The peak numbers of registrations fall to the second half of May. Of the 21 mating groups registrations, 9 were recorded in the second half of May. From June, rutting activity decreases sharply, with only three registrations in the first and in the second halves of June. M.A. Lavov and other authors indicate in their publications, that the mating period for local brown bears runs from the second half or even the end of May to the first half of June [2; 3; 6; 7]. Our data have significantly expanded this range, which, in our opinion, is more likely explained by the small amount of data the aforementioned authors had than by the influence of any other factors, including climatic ones. In a review study of the brown bear reproduction phenology in the Palearctic and Nearctic [18], the breeding period in the northern Carpathians (the nearest southern point to us) is indicated as running from May 1 to June 25, and in southern Sweden (the nearest northern point) — from May 3 to June 9. In both cases, the onset of mating falls on the beginning of May.

Т а б л е 2. — Brown bear main stages of phenology in the Berezinsky Biosphere Reserve in 2020—2024, according to camera trap recordings and mapping of palmar callus prints

Т а б л и ц а 2. — Основные стадии активности бурого медведя в Березинском биосферном заповеднике в 2020—2024 годах, согласно регистрациям с фотоловушек и картированию отпечатков пальмарной мозоли

Stage of activity	Time interval
First records of males / mean multiyear date	11.03—21.03 / 16.03
First records of females with cubs / mean multiyear date	22.03—14.04 / 05.04
First records of mating pairs / mean multiyear date	27.04—2.05 / 30.04
Last records of brown bears during the year	16.11—08.12

The majority of individuals begin to hibernate with the onset of stable subzero temperatures, when the first snow cover is formed. This period occurs in the second half of November — early December, similar data have been reported by the previous researchers [2—4; 6; 7]. In 2022, from November 16—19, approximately 7 individuals of different sexes and ages were still feeding in harvested cornfields close to the reserve's boundary in the vicinity of Kholmovka village, but by November 23—24, no animals were seen there at all. However, 5 individuals (2 adult and a female

with yearlings) remained at the northern boundary of the reserve until November 30. Some individuals can be active even longer. For example, a female with two yearlings was observed in the same cornfields on December 26, 2024, which is our latest registration and is completely unusual for such group of brown bears. According to literary sources, females with cubs are the first to go into the den, and adult males are the last: their tracks can usually be found until mid-December; we have similar data [4; 7].

Long-term data on the brown bear activity in the Berezinsky Biosphere Reserve, obtained between 2020 and 2024, are shown in Figure 2. During the active period, brown bears exhibit pronounced unimodal activity, peaking in the first half of May. Activity increases in March and April, after awakening. High activity in April is associated with preparation for mating and the start of the mating season at the end of this month. Activity stabilizes by the end of June and gradually declines by December.

The post-denning period begins when brown bears leave their dens and lasts until the beginning of the mating season. It begins in the second half of March for males, or in early April for females, and continues until the end of April. Depending on the age and sex group, it lasts from 1 to 1.5 months. During this time, the animals are sedentary. From the second half of April, males begin to move actively and mark their territory. By the end of April, females ready to mate leave their second-year cubs and form mating pairs. In April, the RAI increases significantly, reaching 5—7 TE / 100 TN.

The mating season begins in late April and continues until June, the 20th. This period is characterized by the highest activity of brown bears, with RAI reaching 10 to 15 TE/100 TN. Adult males and females in estrus are primarily active during this period. Males actively defend and mark their territories. Other groups of individuals are inactive during this period and are rarely observed, with the exception of second-year cubs, which often wander near human habitations. In June, breeding activity declines, as does movement activity, with RAI = 5—6 TE/100 TN. By the end of the season, brown bears begin to feed on berries.

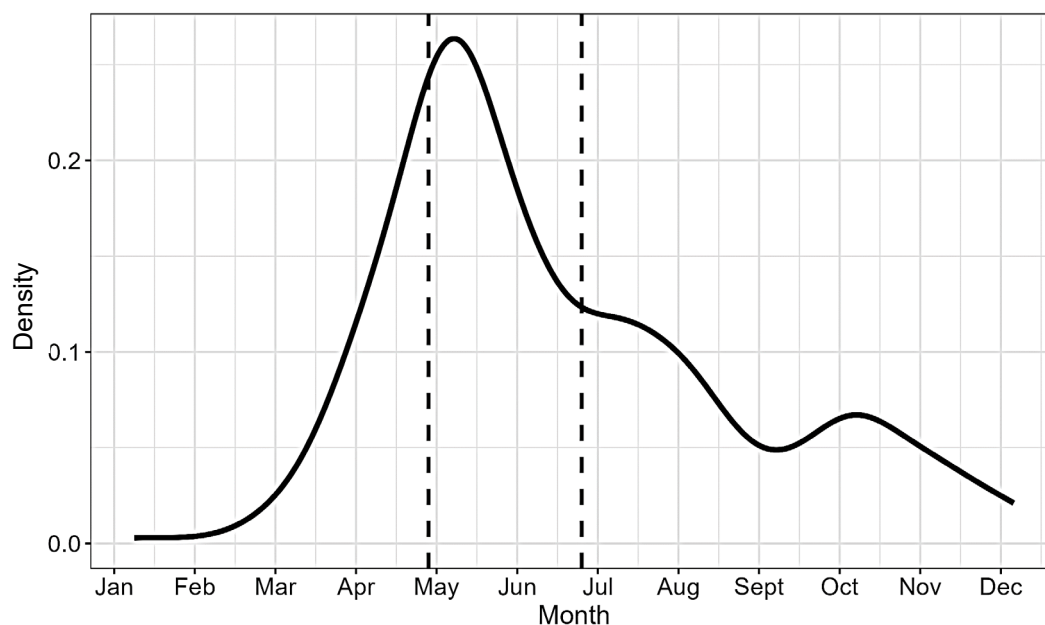


Figure 2. — Graph of brown bears independent detections (Trap Events) density throughout the year for all groups of individuals (the mating season is indicated by dashed lines)

Рисунок 2. — График плотности независимых регистраций (Trap Events) бурого медведя в течение года для всех групп особей (пунктирными линиями обозначен брачный период)

The fattening period (hyperphagia) is the longest and most critical period in a brown bear's life. It begins in late June and lasts until December, covering more than 5 months. This period is characterized by a low, declining activity level with minor fluctuations. The RAI during this period ranges from 6 to 0. The decrease in activity from the second half of July through September is explained by a change in food sources and active movements between different feeding areas. In August, brown bears actively visit oat fields, which are located up to 15 km from their spring home range (Figure 1). The vast majority of individuals in the local population make these movements annually. In August and September, the brown bear population in the reserve decreases significantly. After the oat fields are harvested, some animals return to the reserve. Beginning from the second half of September, bears appear in corn fields, regularly moving between the fields and the reserve, which also affects their activity level. In cornfields, they lead a sedentary lifestyle, feeding on corn in the evening and at night and resting during the day in nearby copses. Cornfields are crucial to their annual cycle, allowing them to accumulate the necessary fat reserves for hibernation. In years when other food sources are poor, corn is the only source of fat reserves. Huge supplies of corn allow large numbers of individuals to concentrate in such fields. The availability of food in late autumn influences the timing of denning; uncultivated cornfields and the absence of snow cover allow some animals to feed until mid-December. In early spring, some individuals also actively visit food fields, scavenging for corn residue.

Minimal activity during the winter period is due to prolonged winter thaws, when meltwater floods their dens. Under these conditions, bears are forced to move to drier areas. No roaming bears have been recorded in the reserve over the past 20 years.

No significant differences in seasonal activity between male and female brown bears have been observed (Figure 3), except that the overall activity level is higher in males. They also have a more pronounced peak of activity, which occurs in the first half of May. In females, the peak of activity is more protracted. This may indicate that most males begin breeding at the same time. For females, this period is more protracted as well. The graph of male activity also shows a slight increase from the second half of November, likely indicating an active migration of this group of individuals to cornfields.

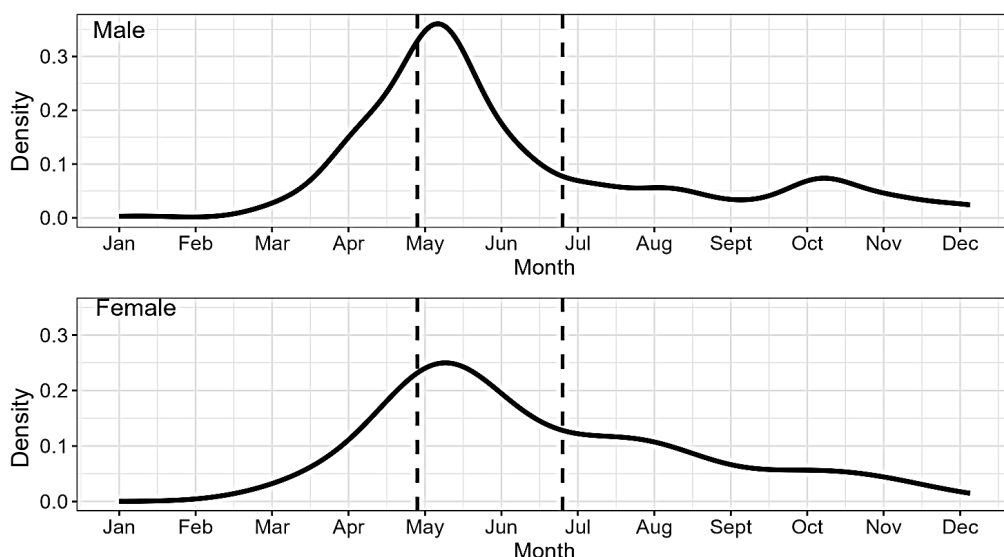


Figure 3. — Graph of brown bears independent detections (Trap Events) density throughout the year separately for males and females (the mating season is indicated by dashed lines)

Рисунок 3. — График плотности независимых регистраций (Trap Events) бурого медведя в течение года отдельно для самцов и самок (пунктирными линиями обозначен брачный период)

Conclusion. Although data on brown bear phenology have been collected in the Berezinsky Biosphere Reserve since the mid-20th century, several aspects remain unclear. Specifically, data on the phenology and duration of hibernation and the first period of wakefulness in bears, depending on weather conditions, require clarification. We have generally established that the animals awaken at the same time regardless of snow cover. It is worthwhile to further investigate whether there are differences in the seasonal activity of brown bears by age and sex. These differences undoubtedly exist, at least, between males and females with cubs, as well as young individuals. However, it is not entirely clear what causes these differences and how consistent they are across the year's weather conditions. These questions will be explored in our future studies, if possible.

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