Trophic migrations of the brown bear in the forest landscapes of the Vostochny Nature Reserve on Sakhalin Island

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Abstract. The article deals with trophic migrations of the brown bear in the characteristic forest landscapes of the Vostochny Nature Reserve. Active life of a bear in the reserve begins after hibernation and is directly related to foraging in different seasons of the year. In the spring-early summer period, bears concentrate in valley forest complexes and coastal-marine landscapes, where, along with plant food, they obtain various products of animal origin thrown out of the sea. During the summer period, from the beginning of the course of salmon and until the end of their spawning, the animals mainly live in the mouths of rivers, and as the fish move, they go upstream and are distributed among their numerous tributaries. During the autumn period, bears concentrate mainly in mountainous forest landscapes and high-altitude natural complexes of the reserve, where they eat ripe berries and pine nuts, their trophic migrations are significantly reduced.

1. Introduction

Many specially protected natural territories of the Sakhalin Region were created, as a rule, without a detailed survey of local landscapes and ecosystems, without establishing all the available biological diversity in them, therefore, without preparing an appropriate scientific justification. In addition, a significant part of them, due to the above and a number of other reasons, is designed to preserve already transformed and, therefore, not unique and not so reference ecosystems. Perhaps one of the few specially protected natural territories of the region, which differs from others in the preservation of forest ecosystems with all its components, is the Vostochny Nature Reserve. This reserve is located in the middle part of Sakhalin Island (Smirnykhovsky district) and covers the territory of the basins of two spawning rivers Pursh-Pursh and Vengeri, with a total area of 68,080 hectares. The reserve presents intact forest landscapes and other natural complexes with an original species composition, complex structure, great biological diversity and a high concentration of rare and endangered species [1, 2, 3, etc.].

The natural conditions of the territory under consideration, in comparison with other regions of the region, are characterized by a number of specific features. The highest mountain system of the island - the East Sakhalin Mountains - is located here, which is oriented mainly in the meridional direction and consisting of two main ridges, Nabil and Central. The cascade of mountain structures and their spurs alternating with intermountain depressions, as well as the proximity of
the Sea of Okhotsk created a peculiar climatic regime in this area with numerous variants of meso- and microclimate, and also caused special soil-forming processes [4, 5, 6, etc.].

Due to these specific natural conditions, very original and diverse mountain taiga landscapes were formed on the territory of the reserve, which predetermined the composition, number and distribution of wildlife, as well as the structure of ecological and faunal complexes as a whole. As part of the theriofauna of the Vostochny Nature Reserve, the brown bear is a constantly inhabiting and widespread species, which inhabits all its natural landscapes and forms the highest population density here. Having a high mobility and flexible position in the trophic chain, the bear occupies a wide variety of biotopes of the reserve, therefore, acts not only as a link between individual elements of landscapes, but also is a kind of indicator of the state of the habitat. The purpose of this work is to determine the role of the most characteristic forest landscapes of the Vostochny Nature Reserve in trophic migrations of the brown bear, taking into account its seasonal activity.

2. Materials and Methods

Field complex observations of the brown bear and traces of its vital activity in the Vostochny Nature Reserve were carried out during 2010–2020. The research was based on visual registration of animals using the global satellite positioning system (GPS), as well as descriptions of the behavior and activity of the individuals encountered in the reserve. The main stationary studies (from May to October) were carried out mainly in the area of the mouth of the river. They included accounting for bears, monitoring their behavior, intraspecific relationships, the method of obtaining and the nature of consumption of food resources, as well as other aspects of animal life [7]. In the estuary zone of the Pursh-Pursh River, individuals were recorded using camera traps (Seelock company) in shooting mode – one frame every 5 minutes. The determination of the food ration was carried out on the basis of the excrement analysis, while taking into account the percentage of the volume of individual food components in each sample, as well as the description of feeding sites and traces of vital activity associated with the food production activities of the brown bear.

The study of the vegetation of the landscapes of the reserve was carried out according to standard methods widely used in geobotanical and forest-typological surveys [8, 9, 10, etc.]. Due to the vastness of the territory of the nature reserve, studies were carried out mainly by route, with detailed work on key sites, geobotanical profiles and test areas.

The data obtained were processed by the methods of geoinformation biogeographic mapping, using the software package ArcGIS Desktop 10, ScanEx Image Processor, Statistica Ultimate Academic 13 [11, 12 etc.]. To build a map of forest landscapes, the results of field research, satellite images of the Landsat series, Sentinel, digital terrain model (SRTM, absolute elevation marks) were used [13, 14, etc.].

3. Research results

Active life of a brown bear in the reserve begins after hibernation and is mainly associated with the search for appropriate food items. The latter are unevenly distributed in the natural landscapes of the reserve, change in different seasons of the year and as a result cause trophic migrations of the bear. In this regard, in the intraseasonal activity of a brown bear, we have identified several periods characterized with the changes in eating behavior and territorial movements: spring-early summer (average duration of 70–80 days, from the first decade of May to the second decade of July); summer (40–50 days, from the third decade of July to the third decade of August); autumn (50–60 days, from the first decade of September to the third decade of October). At the same time, manifestations of a brown bear vital activity were observed in the following forest landscapes of the reserve: coastal-marine, valley forest complexes, larch forests of intermountain depressions, low-mountain dark coniferous forests, stone-birch forests of the middle-altitude belt of mountains, subalpine belt dominated by cedar elfin, high-mountain landscapes with mountain tundra vegetation (figure 1).
Figure 1. Location and structure of forest landscapes of the Vostochny Nature Reserve.

Of course, coastal and marine landscapes, which occupy 0.4% of the area of the nature reserve, play an important role in the life of a brown bear. Despite the insignificant territorial distribution, limited by a narrow strip of the seashore and estuarine areas of rivers, small rivers and streams, these landscapes have many life opportunities suitable for bears to live in the post-winter period. It is in the spring–early summer period that animals actively eat thrown ashore: sea cabbage, crab caviar, shellfish, capelin suitable for spawning, etc. In addition, we have repeatedly observed very noticeable clusters of animals on whale carcasses, sometimes numbering up to 13 individuals at a time. Along with this, on the sea terraces, due to the earlier and intense snowfall, the first plant groupings appear, which allows the bear to use both underground and aboveground parts of plants for food. During this period, bears often visit floodplains and floodplain terraces, where they willingly eat early-growing plants, including their bulbs and rhizomes (figure 2 A).

The mass exits of bears to the coastal zone are also timed to the beginning of the course of salmon in spawning rivers (end of July – beginning of August). However, due to the current trend of reducing the number of pink salmon (the main mass species of spawning salmon in the rivers of the reserve), in the period from 2007 to 2016 there was an increase in the concentration of animals in the estuary zones from 3 to 10 individuals, and from 2017 to 2020 – from 12 to 25 individuals (figure 3). At the same time, the length of stay of animals increased by an average of 10–14 days.

The valley forest complex of the nature reserve is formed by communities dominated by Maksimovich poplar, chozenii, willow, hairy alder (*Populus maximowiczii, Chosenia arbutifolia, Salix undensis, S. cardiophylla, Alnus hirsuta*) and their mixed variants. These communities are found mainly on the second and third river terraces, flat elevated areas of the floodplain, on gentle coastal slopes. Valley complexes are characterized by good development and abundance of herbaceous plants, mainly hygrophytes and mesohygrophytes. Of these, the most commonly used in a brown bear's diet are white-tailed (*Petasites amplus, P. tatewakianus*), krestovnik (*Senecio cannabifolius*), laburnum
(Filipendula camtschatica), cacalia (Cacalia auriculata, C. hastata), dudnik (Angelica ursina, A. genuflexa), Weyrich's ram (Aconogonon weyrichii), kaluzhnitsa (Caltha fistulosa), hogweed (Heraculum lanatum), sedges (Carex sp.) and a number of other species. In addition, a bear willingly eats the fruits of bird cherry (Padus avium) here. During the summer period, from the beginning of the salmon course until the end of their spawning, a bear consumes fish together with plant feeds, so the animals often go to the rivers, and as the fish move, they go upstream and are distributed along their main tributaries (figure 2 B).

Larch forests in the Vostochny Nature Reserve are located mainly in the intermountain depression between the Nabil and Central Ridges and occupy about 30% of the area. Larch (Larix cajanderi) grows here in both extremely dry and damp, stagnant moisture and swampy habitats, thereby forming the appropriate types of forest landscapes. There are about two dozen species in the shrubby tier of larch trees, individual representatives of which are often used in the bear's diet. Oval-leaved blueberries (Vaccinium ovalifolium) are quite abundantly represented in the corresponding types of forest, which, after ripening of berries, belong to the dominant feeds in the diet of a brown bear. In summer and autumn, the bear's diet also includes cloudberrys (Rubus chamaemorus), mountain ash (Sorbus sambucifolia), raspberries (Rubus sachalinensis), pine nuts (Pinus pumila), cranberries (Vaccinium vitis-idaea), etc.

Low-mountain dark coniferous forests dominated by spruce (Picea ajanensis) and fir (Abies sachalinensis) cover about 20% of the territory of the nature reserve. Of the feeding objects of a brown bear, blueberries, mountain ash, lingonberries, rose hips (Rosa acicularis, R. amblyotis), etc. are most often found here. Among other things, a bear uses woodlands as shelters, arranges beds and dens here. And he prefers fir as marking trees to mark his territory.

In the autumn period, after the completion of salmon spawning, the bear's diet changes and is largely formed already from plant resources. In search of food, animals move to high altitudes – from the middle-altitude belt of mountains with stone-birch forests to the subalpine belt dominated by cedar elfin and high-altitude landscapes with mountain tundra vegetation (figure 2 C). Here bears graze mainly on berry bushes and pine nuts. In the late autumn–pre-autumn period, bear food activity is noticeably reduced. At this time, the animals are mostly confined to the mountain forest landscapes of

![Figure 2. Fragments of maps of brown bear distribution on the territory of the Vostochny Nature Reserve in different seasons of the year: A – spring-early summer; B – summer; C – autumn. The color scale reflects the level of probability of the presence of a bear: 5 – high, 1 – low.](image-url)
the reserve, preparing for the winter season, equipping their dens and no longer make significant movements.

Figure 3. Bears at the mouth of the Hungeri during the spawning of pink salmon in the summer of 2019. Photo by I. Nikulina.

4. Conclusion
In the Vostochny Nature Reserve, the brown bear is a constantly inhabiting and widely distributed species, which inhabits all its characteristic landscapes and forms the highest population density here. However, the distribution and number of bears in the landscapes of the reserve varies significantly in different seasons of its life and depends mainly on the composition and structure of the food supply.

In the spring-early summer period, the bear's diet is dominated by herbaceous vegetation, the early-vegetating groups of which are concentrated in valley forest complexes and coastal-marine landscapes. In this regard, the diet of animals, of course, is dominated by herbaceous vegetation, the frequency of occurrence of which in excrement reaches 99%. Along with herbs, bears willingly eat various animal products thrown ashore, even whale carcasses. Accordingly, the localization and concentration of bears during this period is observed in these two types of landscapes.

In summer, the intensity of trophic bear migrations is usually associated with the arrival of salmon to spawn. From the beginning of the salmon course until the end of their spawning, the animals consume fish as the main bait food, and as the fish move, they go upstream and are distributed along their main tributaries. At the same time, bears visit larch and dark coniferous forests along the way and eat ripe berries. The area of seasonal distribution of animals in summer is maximum.

In the autumn season, the localization of bears occurs in mountainous forest landscapes and high-altitude complexes, with regular exits to the riverbeds and rivers. Characteristic food components of animals during this period are berries and nuts of cedar elfin. In the late autumn–pre-autumn period, the trophic migrations of the bear noticeably weaken, they prepare for the winter season, equip their dens and no longer make significant movements. Of course, a brown bear, due to its eurytopicity, is characterized by high mobility in general and uses all the available landscapes of the Vostochny Nature Reserve for life.
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