Assessment of the Impact of Fires on the Steppe Phytocenoses of the Russian Federation

V S Kovalenko¹, V V Glebov¹, G A Kuliev, K Yu Mikhaylichenko, D B Solovev²,³

¹Faculty of Ecology, Peoples' Friendship University of Russia, Miklukho - Maklaya 6, Moscow, 117198 Russia
²Far Eastern Federal University, Engineering school, Vladivostok, Russian Federation
³Vladivostok Branch of Russian Customs Academy, Vladivostok, Russian Federation

E-mail: vg44@mail.ru

Abstract. Steppe zone in the Orenburg region is subject to a powerful anthropogenic load. Most of the territory of the steppes is plowed, and the rest of the land is adapted for pasture or is a Deposit. In addition, fires are a serious threat to the biodiversity of the region's ecosystems. Fires affect the phytocenosis and cause substantial conversion of plant communities. The level of exposure may vary depending on the frequency of the fire, timing and intensity. In recent years, the spread of steppe fires in Russia and their frequency have acquired an extraordinary scale. The climatic conditions of the region (dry, hot summers and long atmospheric droughts) contribute to the spread of fires in large areas. In order to trace the restoration of steppe ecosystems after a fire we have investigated the dynamics of stocks of aboveground phytomass in the 2015-2017 periods, the article considers the initial stages of the leftover post-fire changes in grass communities (Festuca valesiaca, Stipa zalesskii, Artemisia austriaca, Herbae stepposae). Studies have shown how components of above-ground phytomass (live phytomass, rags, litter) accumulate and distribute in the community after a fire. A comparison with similar unburned grasses (Stipa zalesskii, Poa transbaicalica, Herbae stepposae) community with Spiraea crenata. The change of dominant species in the phytocenosis, reduction of the total projective cover in comparison with the control was revealed.

1. Introduction

For centuries, fires have always accompanied human life. Sukachev wrote that the strength of its impact on vegetation fires can be compared with cutting in forest communities and plowing in grass (Sukachev., 1928; Dubinin, Lucia, Radellof, 2010). Periodic wildfires typical of the steppe zones and can be defined as local exogenous environmental factor for the formation of steppe vegetation. Fires can occur both through human fault and natural causes (Titlyanova, 1988). The most destructive effect on the plant communities provide summer fires (Ivanov, 1952). Studies have shown that after burning in the second half of the summer productivity of steppe and dry-steppe phytocenoses decreased by half, plant communities were oppressed the next year (Shinkarenko, 2015).

However, until now there is debate about the benefits and dangers of the steppe fires, and in recent decades, some professionals working in protected areas experimentally burnt steppe and are trying to justify the fall as one way to upgrade steppe (Glebov, 2018; Ilyin, 2011). Opinions about the impact of fires on steppe vegetation varied from a fully negative value before consideration of fires as a natural and sometimes necessary factor for the maintenance of the steppes (Rodin, 1946; Rulev, Kanischev, Shinkarenko, 2016).
In order to trace the restoration of steppe ecosystems after the fire, we studied the dynamics of above-ground phytomass reserves in 2015-2017.

2. Materials and methods
The dynamics of the phytocoenoses studied at monitoring station No. 1, which allocated 2 sites: burnt and not burnt (control). Studies of plant communities were conducted in 2015-2017.

The total projective coverage in the first year after conflagration was 62.3%, 32 species of higher vascular plants were recorded in the community. The phytocoenosis aspect was bright green with bluish streaks of Artemisia austriaca Jacq. The greatest phytocenotic role played xerophytic grasses: Stipa zalesskii Wilensky, Festuca valesiaca Gaudin., Stipa lessingiana Trin. & Rupr. Among the most abundant were mesoxerophyte steppe species: Falcaria vulgaris Bernh., Sisymbrium polymorphism, Scorzonera austriaca Willd., Ferula tatarica Fisch. Ex Spreng and among the xerophytic dwarf shrubs - Artemisia austriaca. In the second and third years, 34 species of higher vascular plants were recorded in the community; the total projective coverage was 59.2%. Although Stipa zalesskii and Festuca valesiaca still played a leading role in the formation of phytocenosis, the abundance of the former increased.

In the composition of the community appeared and reached significant abundance replacement grass (Poa transbaicalica Roshev.) marked replacement steppe mesoxerophytes - Poa bulbosa L. grass was the most abundant perennial mesoxerophyte species: Ferula tatarica, Falcaria vulgaris, Galium rhenanticum. There are increased its projective cover and an abundance of shrubs xerophytic Artemisia austriaca and Artemisia marschalliana Spreng mesoxerophytic.

Thus, the burning growing in 2015 was a herb wormwood, feather-grass, fescue (Festuca valesiaca, Stipa zalesskii, Artemisia austriaca, Herbae stepposae) community with Spiraea crenata. In the following year increased the abundance of Stipa zalesskii, Poa transbaicalica, Artemisia austriaca. The community was mixed grass fescue sagebrush community (Stipa zalesskii, Artemisia austriaca, Festuca valesiaca, Herbae stepposae) with Spiraea crenata and Poa transbaicalica.

In the study of phytocenosis were considered plots of land with mixed grass (Stipa zalesskii, Poa transbaicalica, Festuca valesiaca, Herbae stepposae, Spiraea crenata and Artemisia austriaca).

The composition of phytocenosis did not change significantly during the years of study, the ratio of dominant species remained.

Geobotanical descriptions were performed using standard geo botanical techniques (Mirkin, Naumova, 2009).

3. Results and discussion
On the burning area stocks of aboveground plant mass varied from 49.2 to 151.2 g/m² in 2015, from 54.1-174.7 g/m² in 2016 and from up to 70.2 - 285.3 g/m² in 2017. Total above ground Stocks plant mass is not burning plot exceeded the indicators of burnt plot 2.2-4.1 times.

The maximum stocks of aboveground plant mass on the burning area was recorded in June 2015-2017 (141.9 g/m² and 241.2 g/m², respectively), in the control community the maximum amount observed in September 2015 – 439.4 g/m², and in May 2017 – 561.1 g/m². In the studied years in burning the growing inventory of live above-ground plant mass exceeded the stocks of aboveground dead mass. Stocks live component exceeded the reserves of the dead 2.2-3.4 times early in the season and 0.4-0.5 times at the end of the growing season. In the control community, on the contrary, the stocks of dead mass during the whole observation period exceeded the reserves of living aboveground plant mass 1.5-4.5 times.

The reserves of living aboveground plant mass of the burned community for three years were maximum in May-June 111.3-141.1 g/m², and by autumn they decreased by 2.1-3.3 times. The share of living above-ground plant mass in the first year after the fall was 72.3-81.4%, except for September (41.1%), in the second year it decreased to 31.3-67.2% of the total reserves. The stock of live aboveground plant mass is not burned community was the highest in August 2015 – 149,3 g/m² and June 2016 – 151.2 g/m², and June 2017 – 153.6 g/m². At the same time, from spring to summer it increased...
almost 2.2-3.1 times, and by autumn it was halved. The share of living aboveground plant mass from total reserves in the control community in 2015 was 164.2%, and in 2017-18.2-33.1%.

There are at the beginning of the growing season in the burning community in the living aboveground vegetation prevailed motley grass. By the end of the summer season began to dominate cereals and semi-shrubs. Edificatory community in burning the phytocoenosis within three years was cereals, but by weight and the share they are inferior to other plant communities. There are several opinions about the impact of fires on turf crops. Some authors believe that the grasses suffer little from fire, as the buds again are below the soil surface (Pavlejchik, 2015). Few more suffering fescue turfs because it is less submerged in soil. Other studies have noted significant damage to turf, or at least depression and reduced yields (Popov, 2004). According to E. M. Lavrenko "in the steppe fires burn only dry piece of turf, but the dead part is often surrounded by weaker shoots, so burnout contributes to aging turf" (Lavrenko, 1941; Erofeev, Glebov, 2018).

After the fire of competition in the community is weakened, the grains were in a depressed condition, and stern brae perennial grasses increased their abundance and vegetative mass by the end of the growing season, when the entire live plant mass herbs goes into a cloth or paper litter, the proportion of surviving grains increases.

At the beginning of the growing season of 2015, the living mass of cereals in the burning community was insignificant and amounted to 14.2 g/m² (33.4%) of the reserves of living plant mass, yielding to grasses 19.4 g/m² (46.7%). During the growing season, the plant mass of cereals increased and in August reached a maximum of 56.3 g/m², the share of cereals in this month was 71.2%.

In 2016 the maximum amount of living plant mass of grains was noted in May to 52.2 g/m² (39.2%) to August, these figures supply decreased, and only to the Sep idea-had significantly increased in the percentage of reverse trend was observed towards the end of the growing season, the percentage of living grains in the common stocks of living plant mass increased to 61%.

In 2017 the maximum amount of living plant mass of grains was noted in late May and 61.3 g/m² (39.6%) to August, these figures mass is also decreased, and by September had increased slightly.

In the control community at mass and share in the common stock of live plant mass dominated by grasses 21,3-of 99.1 g/m² (41.2-64.1%) in 2015, 45.2-99.6 g/m² (40.2-66.3%) in 2016, 51.2-111.3 g/m² (41.1 62.3 per cent) in 2017 with the exception of September 2015 and July 2016, when several more were weight and the proportion of dwarf shrubs. These differences were marked by high abundance and a more active development of dwarf shrubs flowering in autumn 2015 (Artemisia austriaca, A. marshalliana) and in the spring and summer in 2016 and 2017 (Astragalus macropus, Thymus marschallianus).

The stocks of living plant mass herbs burning in the phytocoenosis within three years were highest in spring and summer control. This is due to increase after the fire phytocoenotic role of the spring flowering species among perennial Scorzonera austriaca, including ephemerons (Tulipa biebersteiniana Schult. et Schult. fil., Allium tulipifolium Ledeb.) and biennials Sisymbrium polymorphum. The minimum value of mass of live grass on the burned area occurs in August-September, in a test on Sept. At the same time, in the affected areas of the fire, the maximum value of live plant mass reserves exceeded the minimum in 2015 by 3 times, in 2016 by 7 times, in 2017 by 11 times. In the control variant showed an increase in 2015 of 3 times, in 2016 - 4 times in 2017 - 5 times.

In 2015, the burned number of shrubs reached a maximum value and was in September-21 g/m², (68%) and fruiting was observed in the species Artemisia austriaca. In the control community this year, the reserves of live plant mass of semi-shrubs increased to 57 g/m² by June, and their share was 38%. The following year, in the burning phytocoenosis, semi-shrubs gained a maximum mass in June and August of 26 g/m² and 25 g/m², respectively, not significant compared to the control area, the reserves of which increased to 95 g/m² by July, in percentage terms, their share was 48%.

The total stock of dead weight was changed in a burning phytocoenosis from 13.1 g/m² to 51.1 g/m² in 2015, from 16.3 g/m² to 64.5 g/m² in 2016 and from 66.2 g/m² to 141.1 g/m² in 2017, with a maximum in late summer-autumn period in the control plot from 189.2 to 358.3 g/m² in 2015 and from 294.2 to 432.2 g/m² in 2017, with a maximum in spring.
In the structure of the above-ground plant mass at the control site in both years of the study during the whole season, the mass of the litter exceeded the mass of rags (1.5-3 times). On the burning site, this ratio was established only by August 2017, and before that, the mass of rags was more than the mass of the litter, which in the first year was practically absent.

Despite the predominance of rags over litter in the burning phytocenosis, the supply of rags was also not large, especially in the first post-fire year: 1.3-31.1 g/m² compared to 53.2-102.4 g/m² in the control phytocenosis. Significant differences of this index is preserved in the second year after the fire, when the supply of rags was varied on a burning platform from 29.2 g/m² to 65.1 g/m², and the control of 113.3 g/m² to 179.1 g/m², and every month this figure was higher by 2.3-3.5 times.

Seasonal dynamics of stocks of rags in the first year of the study was similar in the burning and control areas. It was characterized by a gradual accumulation of rags from spring to autumn. In 2017 to compare the plots differed accumulation peaks: June - burning in plant communities, May in not burning. Minimum stocks of rags: in the burning - September, in the not burning - June and August.

The stock of the litter mass in the studied years in all months on the burning site was significantly lower than in the non-burning one. In the burning platform they changed from 0 to 19.3 g/m² in 2015; from 13.1 g/m² to 51.1 g/m² in 2016; from 16.9 g/m² to 88.2 g/m² g in 2017 in not burning the court - in 2015 from 136 g/m² to 270 g/m² 151 g/m² up to 281 g/m² in 2016 and from 181 g/m² to 297 g/m² in 2017.

Seasonal dynamics of litter stocks also differed. Despite significant differences in weight, General trends in the seasonal dynamics of stocks of bedding and rags remained in 2015 in the study and control phytocenosis, they were characterized by a gradual accumulation by autumn. In 2017, there were differences in the seasonal distribution of minimum litter stocks. For the burning community, they were held in May, and in the control - in June. In both cases, by the end of the 2016 season, the litter mass was decreasing.

4. Conclusion

According to the results of the study, it can be noted that after the fire there is a transformation of the plant community expressed in the following:

1) There is a change in the basic characteristics of phytocenoses:
   - Reduction of the total projective cover in 2 times, in comparison with not burning phytocenosis;
   - The change of the ratio of dominant species, increased phytocoenotic role of Festuca valesiaca phytocenosis in a burning;
   - Changes in the composition of phytocenoses, the appearance or increase in the abundance of juveniles or weeds.

2) There is a change in the reserves of above-ground plant mass and its individual components:
   - stocks total aboveground plant mass burning of the community in the first year after a fire less inventory not burning communities 4.2-4.6 times in the second year almost 3 times;
   - inventory of live above-ground plant mass in the burning community in 2015, almost 2 times, and in 2017 1.4 times less than the reserves are not burning community;
   - inventory is dead weight in the burning community in the first year after Pala was less inventory not burning communities in 3-7 times in the first year 3-4 times in the second year and 3 times in third year;
   - burning in the communities dead weight exceeds the stocks of living plant mass in 0.2-2.4 times, in not burning the community 1.2-4.6 times.

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