Effects of Different Restoration Measures on Species Diversity and Aboveground Biomass in the Ehe River Headwaters Gold Mining Area (Postprint)

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Date: 2019-06-13T00:00:00+00:00

Abstract

This study investigated the abandoned gold mining area in the E' er River headwaters. During 2011–2015, vegetation restoration effects were analyzed from the perspective of grassland plant diversity and biomass by implementing different restoration measures in the damaged mining area. The results showed that: (1) Different restoration measures increased species numbers in each plant community by 5%–30%, indicating that restoration measures led to a certain degree of ecological environment recovery in the mining area. (2) Based on comprehensive analysis of vegetation community structure, coverage, aboveground biomass, and species diversity indices, measures A5 (leveling + sheep enclosure), A4 (leveling + water supplementation), and A3 (leveling + soil covering + blackcurrant) demonstrated more significant restoration effects than other measures. (3) Regression analysis between vegetation richness index (R), Shannon-Wiener index (H), Simpson index (D), and Pielou (Jsw) index and aboveground biomass for each sample plot revealed that exponential curve fitting provided the best relationship, indicating a significantly positive correlation between species diversity and aboveground biomass ($P < 0.05$). This study can provide reference and guidance for vegetation restoration and reconstruction in similar mining areas.

Full Text

Effects of Different Restoration Measures on Species Diversity and Aboveground Biomass in the Gold Mining Area of the Ertix River Headwaters

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Abstract

In recent years, due to gold mining exploitation and intensive grazing along the Ertix River in Xinjiang, China, the local ecological environment has deteriorated drastically. The ecological restoration of mining areas has become a critical issue for scholars worldwide. Implementing appropriate ecological restoration measures in damaged mining areas can not only reduce the self-recovery period but also foster different community types adapted to the unique habitat conditions of mining areas, thereby enhancing species diversity and ecological stability. This study investigates five different restoration measures in abandoned gold mining areas along the Ertix River using sampling experiments initiated in October 2011. The five restoration measures included: (1) artificial soil covering (soil collected from the surrounding area was evenly applied at 2–3 cm thickness after surface leveling); (2) black currant planting (black currant planted after surface leveling); (3) water replenishment treatment (spring floodwater was introduced via overflow and river water supply); (4) sheep encamping (to improve soil nutrient conditions and optimize the vegetation growth environment); and (5) mud distribution by spraying (water and soil mixed at a 9:1 volume ratio and sprayed evenly using a water pump). Additionally, sheep dung coverage was tested at thicknesses of 0.5 cm, 1.0 cm, 1.5 cm, and 2.0 cm after surface leveling, with recovery effects observed one year later.

Eight experimental areas (400 m × 200 m each, comprising 56 sample plots total) were established. Species type, frequency, height, and other indicators were recorded for each experimental site, and aboveground biomass was determined using the harvest method. The effects of different restoration measures on plant species diversity and biomass were analyzed using SPSS and Excel statistical packages. The results showed: (1) Different restoration measures significantly improved the ecological environment of the damaged mining area, increasing species richness by 5% to 30% in each plant community. (2) Considering vegetation community structure, coverage, aboveground biomass, and species diversity, treatments A5 (sheep encamping), A4 (water supplement), and A3 (soil covering + black currant planting) demonstrated the best restoration outcomes. (3) Regression analysis revealed a significant positive correlation between species diversity and aboveground biomass ($P < 0.05$). These findings provide valuable references for vegetation restoration and reconstruction in similar mining areas.

Keywords: Ertix River; artificial restoration measures; mining area; species diversity; biomass

2. Methods

2.1 Experimental Design

The experiment was conducted in the abandoned gold mining area of the Ertix River headwaters [Figure 1: see original paper]. In October 2011, eight experimental plots were established, each measuring 400 m × 200 m, containing 56 sample plots in total. The restoration measures included: (A) artificial soil covering (2–3 cm thickness), (B) black currant planting, (C) water replenishment (spring flood introduction), (D) sheep encamping, (E) mud spraying (water:soil = 9:1), and (F) sheep dung coverage at four thicknesses (0.5 cm, 1.0 cm, 1.5 cm, 2.0 cm). Vegetation surveys recorded species composition, frequency, height, and coverage.

2.2 Data Analysis

Species diversity indices were calculated including: Richness index (R), Shannon-Wiener index (H), Simpson index (D), and Pielou evenness index (Jsw). Aboveground biomass was measured using the harvest method.

2.3 Statistical Analysis

Data were processed using Excel and SPSS 10.0. Duncan' s multiple range test was used for treatment comparisons. Regression analysis examined relationships between species diversity and aboveground biomass.

3. Results

The effects of different restoration measures on species diversity and aboveground biomass showed: (1) All restoration measures significantly improved the vegetation environment, increasing species number by 5–30%. (2) Based on community structure, vegetation coverage, aboveground biomass, and species diversity, treatments A5 (sheep encamping), A4 (water supplement), and A3 (soil covering + black currant planting) were most effective. (3) Regression analysis revealed a significant positive correlation between species diversity and aboveground biomass ($P < 0.05$).

5. Conclusion

(1) Different restoration measures significantly improved the vegetation environment and increased species richness in the mining area. (2) The combination of soil covering, water supplementation, and sheep encamping showed optimal restoration effects. (3) A significant positive correlation existed between species diversity and aboveground biomass. These results provide scientific guidance for vegetation restoration in similar mining areas.

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[22] Standard calculation method for vegetation indices.

[23] General methodology for community surveys.

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[33] Standard error calculations.

[34] Community ecology methodology.

Note: Figure translations are in progress. See original paper for figures.