

# Experience in the development of regulations based on the results of experimental studies for the conservation and restoration of biodiversity

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**Abstract:** One primary cause of biodiversity loss is the absence of standardized guidelines and regulations that provide clear instructions for implementing conservation measures. The development of technological frameworks, solidified in regulatory acts, enables the creation of a methodological foundation for biodiversity conservation and restoration for industrial companies as part of their corporate ESG policies. Between 2013 and 2023, the Kuzbass region gained significant experience in developing regulatory legal acts (RLAs) based on restoration technologies for various ecosystems on mine spoil heaps, as well as conducting environmental assessments and compensatory measures. A crucial part of this work involves publishing methodological recommendations for coal companies and integrating innovative technologies into the content of state standards in the field of "Environmental Protection" and Best Available Technologies (BAT). A total of 6 methodological recommendations were developed, of which 3 technologies were included in the BAT list for biodiversity restoration, and another 3 technologies are undergoing the stage of drafting a state standard. The preparation of new GOST-R standards helps industrial companies perceive biodiversity as an opportunity to demonstrate their environmental responsibility and minimize financial and reputational risks.

## 1 Introduction

Mining activities inevitably result in irreversible alterations to natural landscapes and the destruction of habitats with unique ecosystems and rich biodiversity, including rare and endangered species listed in Red Data Books. Russian legislation is undergoing significant changes and is constantly supplemented with new regulations aimed at preserving and restoring biodiversity. However, a problem arises with the methodological support for activities at the stages of identifying habitats of rare species, conducting compensatory measures, restoring ecosystems, and recovering populations of rare plants and animals. The

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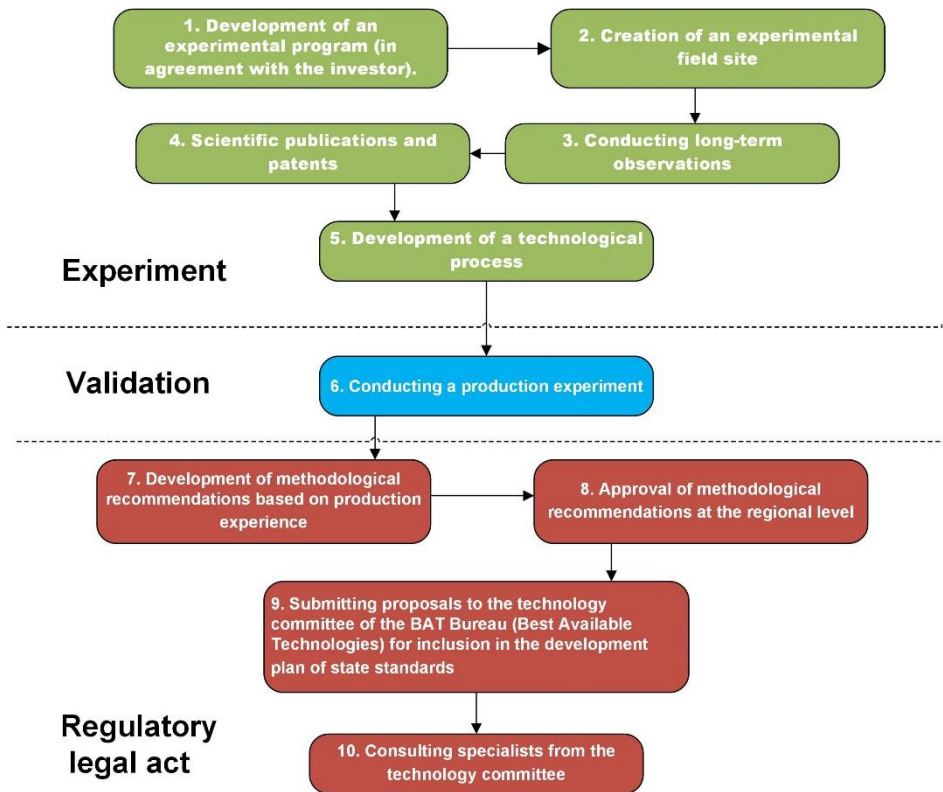
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absence of clear, consistent, and practically feasible recommendations puts companies in a difficult position, as it becomes impossible to fulfill environmental obligations without risking fines for missed deadlines or the loss of biological species. This can impact the stability of the entire enterprise. The problem is exacerbated by the fact that design organizations have no basis for including innovations in a working project without referring to a current regulatory act. Consequently, it is more convenient for company management to completely disregard biodiversity in their activities in order to avoid risks. As a result, the negative impact on biological species and ecosystems intensifies. Therefore, the goal of our work is to develop methodological recommendations and state standards in the areas of ecosystem restoration, environmental impact assessment, and compensatory measures, so that biodiversity, as an object of industrial activity, becomes an opportunity for the company to demonstrate its environmental responsibility and minimize financial and reputational risks.

## **2 Materials and Methods**

Modern scientific methods allow for the resolution of challenges in the mining industry through the application of a hierarchical approach to minimizing impacts on biodiversity [1, 2]: a) preliminary surveys of licensed areas, b) compensatory measures; c) monitoring of biodiversity in areas of direct and indirect impact; d) restoration of biodiversity and ecological functions of disturbed areas. Beyond the realm of academic publication, scientists face the necessity of developing regulatory legal acts (RLAs) to facilitate the practical application of innovations in production schemes. These subordinate legislative acts serve as the foundation for incorporating biodiversity conservation methods into mining project development and standardized sections on environmental impact assessment, environmental monitoring, and reclamation of disturbed lands.

The process of refining an innovative technology into a state regulatory legal act (RLA) involves ten stages (see figure).



**Fig.** Schematic representation of the stages involved in creating a regulatory legal act

Since biodiversity conservation and restoration methods target living organisms, observations and data collection should be conducted over extended periods to eliminate the possibility of chance results from field experiments [3]. Furthermore, field experiments are highly susceptible to annual meteorological variations. Therefore, observations at experimental sites are conducted for a minimum of three years to obtain statistically reliable data and identify trends in ecosystem and population development.

Following research conducted at an experimental field site, the technological process is piloted in a production experiment, and methodological guidelines are developed. Subsequently, one of the authors and developers of the new methods engages in correspondence with the specialized technical standardization committee for "Best Available Technologies." Through this committee, proposals are submitted and approved, after which work is undertaken in collaboration with the committee's specialists to draft a new state standard. Following expert review of the document and a positive collegial decision by the Federal Agency for Technical Regulation and Metrology, the new GOST-R standard is approved.

The entire process of implementing this plan requires 7-8 years of focused work, culminating in the transformation of scientific research into a state standard. The timeline can be extended due to lengthy negotiations with investors who may lack sufficient motivation to fund the work; or with municipalities where the experiment is conducted; or with regional governments, where various reasons may delay the review and approval of methodological recommendations. The mere existence of methodological recommendations approved at the regional level allows companies to include these methods in their corporate sustainability strategies, programs, and standards without contradicting federal legislation

[4]. The development of a state standard makes new biodiversity conservation and restoration methods entirely legitimate, as their implementation meets all criteria within this category of Best Available Technologies (BAT) at the national level [5].

### 3 Results and Discussion

Findings from scientific research into the patterns of plant community formation on mine spoils in Kuzbass [6, 7, 8] served as a catalyst for a shift in the paradigms of land reclamation. This shift moved away from creating monoculture plantations towards the restoration of diverse plant communities and the ecological functions of industrial sites. Significant advancements were achieved in the Kemerovo region—Kuzbass between 2013 and 2023. Over a decade, researchers at the Kuzbass Botanical Garden (Federal Research Center of Coal and Coal Chemistry, Siberian Branch of the Russian Academy of Sciences) conducted experimental studies to develop innovative technologies for biodiversity conservation and ecosystem restoration [9, 10, 11, 12]. With the participation of the Kuzbass Government and industrial partners from coal companies, a set of methodological recommendations was prepared and recommended for regional application at coal enterprises. Subsequently, proposals were submitted to the technical committee of the BAT Bureau to develop new state standards in the field of reclamation of disturbed lands, conservation, and restoration of biodiversity. Currently, these state standards are under development as planned (table).

**Table.** Readiness level of innovative technologies for inclusion in GOST-R

<b>No.</b>	<b>Title of the methodological recommendations</b>	<b>Year of publication</b>	<b>GOST</b>	<b>Document Status</b>
1	The application of a comprehensive suitability index for the reclamation of disturbed lands from coal mining dumps in the Kuzbass region	2017	57446-2017	Approved and put into effect
2	Restoration of meadow-steppe vegetation on coal mining dumps in the Kuzbass region	2017	57446-2017	Approved and put into effect
3	Forest reclamation of disturbed lands at coal mining enterprises in Kuzbass	2017	57446-2017	Approved and put into effect
4	Reconstruction of the geological foundation and a viable soil-plant layer on mining dumps	2022	–	In the process of development
5	Preservation of rare plants in rocky habitats using ex situ and in situ methods during mineral extraction	2023	–	In the process of development
6	Creation of nature-like forest ecosystems on coal mining dumps in the Kuzbass region	2024	–	In the process of development

### 4 Conclusion

All nature-like technologies meet the criteria of Best Available Technologies (BAT), meaning they have a significantly greater environmental impact compared to traditional methods, while having a similar or slightly higher cost due to additional technological operations. Ecosystem restoration technologies utilize a variety of plant species recommended for the Kemerovo Oblast - Kuzbass region or consisting exclusively of zonal flora species. All technologies can be adapted for other regions with similar natural and climatic conditions. It can be stated that at present, all basic technologies for restoration and

landscape biological reclamation have been developed in Kuzbass, allowing for the effective restoration of biodiversity and a significant increase in the economic and ecological value of disturbed lands. The developed methodological recommendations can be used to develop corporate documents within the framework of industrial companies' ESG strategy development plans. The preparation of new Russian state standards in the field of biodiversity conservation and restoration will ensure the widespread legal application of these BATs in the mining industry in the near future.

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