Modern methods for calculating the amount of damage caused to aquatic biological resources

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Abstract. Environmental impact assessment (EIA) in planning any economic activity is an important point not only for its resolution, but also for the preservation or replenishment of biological objects of nature. Scientists of the Federal State Budgetary Scientific Institution “Krasnodar Research Centre for Animal Husbandry and Veterinary Medicine” have developed a simplified electronic template for calculating the amount of damage to aquatic biological resources when planning the economic activities of enterprises in the immediate vicinity of water bodies. It allows you to determine the harm from the implementation of economic and other activities, as well as calculate the amount of damage to aquatic biological resources from its conduct, including their habitat.

1. Introduction

Environmental Impact Assessment (EIA) is a type of activity for the collection, systematization and accounting of the consequences of the environmental impact of economic and other activities for its implementation. It is an important component of the environmental safety program and should be based on a permanent environmental model.

Environmental impact assessment is legally established by the Federal Law "On Environmental Protection" dated January 10, 2002, No. 7-FZ (Article 32).

This assessment is necessarily carried out in the development of planned economic and other activities that may have a direct impact on the environment and biological objects inhabiting its area.

To carry out the assessment, reliable data from environmental engineering surveys are used. All the necessary materials must be provided by the enterprise for the calculation of the EIA for the planned economic activity when passing the environmental impact assessment.

An obligatory criterion for the modern design of any enterprise is the use of low-cost, environmentally friendly solutions that reduce harm to the environment while reducing harmful
emissions into the atmosphere, soil, and water bodies. Organizations should develop measures to prevent or reduce environmental pollution.

An important factor is that the growth in the number of small businesses has an additional increase in a certain type of environmental pollution, since small entrepreneurs often have a low level of development of EIA [1].

Environmental studies, which must be carried out at all stages of the use of natural resources, serve to analyze the current state of the environment and determine changes in living and non-living objects under the influence of anthropogenic factors [2].

The role of environmental analysis in carrying out EIA is most important with the support of small businesses and requires the development of convenient calculation programs [3].

The increased pressure on aquatic biological resources has led to numerous activities in the field of research and legislation, both based on ecotoxicological evidence, and acting on the basis of the precautionary principle. It takes a broad look at natural and technical water systems, including various scales and involving fundamental and applied science, which allows us to develop modern, effective and holistic research tools for calculating the amount of damage caused to aquatic biological resources.

Problems in the field of conservation and management of biological resources require the use of research methods for the quantitative assessment of the harmful effects on populations, as well as political decisions on the permissible limits of damage. Few studies quantitatively evaluate the population effects of individual harmful factors, and only a few - synergistic effects.

Modern technological and methodological technologies have significantly increased the number and variety of available hydrological, biogeochemical, and environmental indicators of the state of aquatic biological resources [4, 5].

2. Calculation of the amount of harm that can be caused to aquatic biological resources

Of great practical importance for agricultural enterprises is the calculation of the amount of harm that can be caused to aquatic biological resources from the planned economic and other activities. A separate section of the methodology is devoted to such calculation, in which the calculation methods used in the types of activities conducted in water bodies of fishery importance, water protection, fish conservation and fisheries conservation zones, as well as the costs of restoring the disturbed state of aquatic biological resources, are determined.

Calculations are performed in the following cases. First, they are used when planning the construction, reconstruction, overhaul of capital construction facilities, placement of economic and other activities, introduction of new technological processes and production of works that affect the state of biological resources and their environment. Second, they are applied in order to assess the possible consequences of negative impact this activity on their condition; in risk assessment and environmental insurance; in assessing the possible (predicted) consequences of contingencies and emergencies on the state of aquatic biological resources. When determining the harm caused to aquatic biological resources, special formulas are used that allow making calculations based on the specifics of possible damage.

The amount of damage caused to aquatic biological resources as a result of violation of legislation in the field of fisheries and the conservation of aquatic biological resources, natural disasters, abnormal natural phenomena, natural and man-made emergencies, is calculated in cases of death of aquatic biological resources, reduction of fish productivity of a water body, deterioration of living conditions and reproduction of aquatic biological resources. It happens due to the complete or partial loss of spawning and breeding sites, feeding, wintering and their migration routes as a result of the implementation of business and other activities in violation of the requirements of the legislation of the Russian Federation. These are operation, construction, reconstruction, overhaul of enterprises, structures and other facilities, water withdrawal from water bodies of fishery significance without taking measures to prevent the ingress of water biological resources into water intake devices and structures, works in water bodies of fisheries beginnings in water protection zones of water bodies and
their coastal protection zones, in fish protection and fisheries conservation zones with violation of the law). This also includes pollution of the living environment of aquatic biological resources with harmful substances (acids, alkalis, pesticides, agrochemicals, etc.), industrial and consumption wastes, hydrocarbon raw materials and its derivatives, discharge into water bodies of fishery value and fish protection zones of harmful substances. The maximum permissible concentrations of such substances in the waters of water bodies of fishery value have not been established [6, 7].

The sources of obtaining the initial data used in the calculation of damage are the results of surveys, laboratory analyses and examinations carried out as part of administrative investigations of the facts of the death of aquatic biological resources and pollution of their habitats. These include state monitoring of aquatic biological resources, industrial environmental control, obtaining scientific data from subordinate research organizations and federal state budgetary institutions (basin administrations) for the organization of fisheries and the conservation of aquatic biological resources of the Federal Agency for Fisheries, the tables of the appendix to the methodology.

Data on the presence and prevalence of objects of the animal world in a certain territory are obtained by assessing the current state of the environment.

The section on wildlife protection should logically supplement the remaining sections of the document and not contradict them, for example, the impact assessment on the land and plant cover, restoration issues, environmental impact assessment, environmental and economic assessment, and other sections.

Compensation payments for objects of the animal world are not provided for by the current legislation of the Russian Federation, but it is necessary to include measures for their protection and calculation of costs for the implementation of the relevant measures in the project documentation.

Damage to aquatic biological resources during the work is mainly caused as a result of the withdrawal of land for construction projects, on which there is almost complete destruction of the existing biocenoses.

In addition, in the areas adjacent to the land allotment strip, that is, in the influence zone (from 1.5 to 3.0 km in each direction from the objects under construction), there is a decrease in the majority of the living species of animals and birds during construction due to manifestations of anxiety factor (AF). It is predicted that the species composition and population density will recover after completion of construction work. The animals are supposed to adapt to changing living conditions.

It can be noted that the strength and intensity of the manifestation of the anxiety factor in the construction of linear facilities (pipelines, roads, etc.) are less than those in the construction of large areas facilities (factories, ports, etc.). This is due to the amount of equipment used, people, the scale and intensity of the work, as well as the timing of construction and the area of land seized for facilities. In this regard, the zone of manifestation of the disturbance factor for linear objects can be taken as 1.5 km in each direction, and the zone of influence of large area objects - 3.0 km in each direction.

Modern publications on damage calculation in the Russian Federation can be conditionally divided into several types: on issues of applicable rates, analysis of mechanisms for calculating damage to biological resources and issues of application in judicial practice. There is a lack of publications on the issues of calculating damage that may be required in the training of specialists [8, 9].

Environmental Impact Assessment (EIA) is an integral part of the design documentation. This procedure must be carried out before the start of the project, and if the results of environmental impact will have a significant negative effect, the project should be adjusted or canceled.

3. The program for calculating the amount of damage caused to aquatic biological resources

The Federal State Budgetary Scientific Institution "Krasnodar Research Centre for Animal Husbandry and Veterinary Medicine" has developed a program for calculating the amount of damage caused to aquatic biological resources. In this case, the calculation methodology approved by the Federal Fisheries Agency of the Russian Federation is used.
To calculate the amount of the total amount of damage caused to aquatic biological resources as a result of violation of legislation in the field of fishing and conservation of aquatic biological resources, as well as a result of natural disasters, anomalous natural phenomena, emergency situations of a natural and man-made nature, 20 formulas are used.

In this case, the amount of damage to aquatic biological resources is determined by the total value of its constituent components, calculated for each individual species (Figure 1).

\[
\frac{(S - s) \times S}{P}, \quad n=0
\]

where:
- \(n\) - the number of lost (taken dead) adults of aquatic biological resources for each type of aquatic biological resource, pcs;
- \((S - s)\) - indicator of the lost fish productivity for a particular type of aquatic biological resource, which is defined as the difference between the indicators of fish productivity for this type of a water body of fishery significance before negative impact (S) and after (s), kg/ha;
- \(S\) - area of negative impacts, ha;
- \(P\) - average weight of an individual of a species of aquatic biological resource, kg.

| B | S | P |
|---|---|---|
|   |   |   |

| E | n1 | n2 | n3 | n4 | n5 | n6 | n7 | n8 | n9 | n10 | n11 | n12 | n13 | n14 |
|---|----|----|----|----|----|----|----|----|----|------|-----|-----|-----|-----|
| 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0   | 0   | 0   | 0   |

The calculation of the amount of damage caused by the deterioration of living conditions and reproduction for aquatic mammals:

\[
N'= Z \times (n' - n'^*) + \frac{n' \times Q \times c \times n' \times r \times P' \times r}{100}, \quad n'=0
\]

where:
- \(N'\) - the amount of damage from the deterioration of living conditions and reproduction of aquatic mammals, rubles;
- \(Z\) - cost of products obtained from 1 specimen of a medium-sized mammal, rubles;
- \(n'\) - number of mammals before the start of a negative impact, pcs;
- \(n'^*\) - number of mammals after a negative impact, pcs;
- \(Q\) - average family fertility, pcs, babies;
- \(c\) - multiplicity of assessment for the life period of the life of the mammal, times;
- \(r\) - the proportion of females in the herd, %.

| E | n1 | n2 | n3 | n4 | n5 | n6 | n7 | n8 | n9 | n10 | n11 | n12 | n13 | n14 |
|---|----|----|----|----|----|----|----|----|----|------|-----|-----|-----|-----|
| 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0   | 0   | 0   | 0   |

The total volume (DP) of lost aquatic biological resources is determined as the sum of indicators (DP) determined in formulas 3, 4, 6, 8, 9, 10, 12 and 17.

\[
DP = 0
\]

Figure 1. Calculation of the amount of harm caused to aquatic biological resources as a result of violation of legislation in the field of fishing and conservation of aquatic biological resources, as well as a result of natural disasters, abnormal natural phenomena, emergency situations of natural and man-made nature.

To calculate the amount of damage to aquatic biological resources from the implementation of the planned economic and other activities that affect the state of aquatic biological resources and their habitat, 28 formulas are used. Also, such parameters are calculated as the norms of specific capital investments and specific operating costs for the release of one specimen of reproducible larvae or...
juveniles of aquatic biological resources, their specific values per 1 ton of reproduced species of aquatic biological resources (Figure 2).

\[
N = B \times (1-PB) \times S \times K_2 \times \left( \frac{K_3}{100} \right) \times d \times \Theta \times 10^{-3}
\]

or by the formula:

\[
N = B \times (PB) \times S \times K_2 \times \left( \frac{K_3}{100} \right) \times d \times \Theta \times 10^{-3}
\]

where:
- \(N\) - losses (amount of harm) of aquatic biological resources, kg; t;
- \(B\) - average long-term value of the total biomass of food organisms of benthos for a given season of the year, g/m²;
- \(P\) - coefficient of conversion of biomass of food organisms into the products of food organisms;
- \(S\) - area of the impact zone where the death of food organisms of benthos is predicted, m²;
- \(K_2\) - coefficient of efficiency of using food for growth;
- \(K_3\) - average for a given ecosystem and season of the year coefficient of use of food supply by benthiophagous fish, kg;
- \(d\) - the degree of impact, or the proportion of the number of dying organisms from their total number (in fractions of a unit);
- \(\Theta\) - the value of the multiplying coefficient, taking into account the duration of the negative impact of the planned activity and the recovery time; $10^{-3}$ - multiplier for converting grams to kilograms or kilograms to tons.

The program is maximally focused on simplifying the work of users: fields of input values are colored green, the results are displayed on a yellow background. The program contains an instruction that allows you to quickly understand the calculation method and get started.

The program for calculating the amount of damage to aquatic biological resources can be used at fish-breeding enterprises of various forms of ownership, as well as a teaching aid in secondary and higher educational institutions.

4. Conclusion
A simplified program for calculating an environmental impact assessment for the implementation of economic activities of enterprises in the immediate vicinity of water bodies will help to calculate the Environmental Impact Assessment by specialists of small enterprises and for training students of environmental faculties of higher and secondary educational institutions.

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