# The Role of Ecotourism in Biodiversity Conservation on the Caspian Sea Coast of the Shirvan Nature Reserve

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**Abstract**

This article presents a scientific and theoretical analysis of the impact of ecotourism activities on the conservation of biological diversity in the coastal region of the Shirvan Nature Reserve. The main objective of the study is to determine the role of ecotourism in biodiversity conservation based on the natural ecological characteristics of the reserve, as well as to assess the principles of sustainable development of the activity. The study of the protected area's natural geographical features and the ecological benefits of its position on the Caspian Sea coast is a component of the research endeavor. Another part is to systematically study the interactions between semi-desert ecosystems and wetlands based on scientific sources. The study analyzed the diversity of the reserve's flora and fauna. The role of ecotourism in the conservation of rare and endangered species was assessed. It has been found that well-planned, scientifically based ecotourism activities can make a positive contribution to the protection of biodiversity and the strengthening of environmental awareness. In addition, ecotourism has been found to have a positive impact on the socio-economic development of the local population. It has also been found to increase employment and foster a responsible attitude towards environmental protection. However, it has been observed that the unplanned and uncontrolled implementation of ecotourism has a negative impact on ecosystems. The text emphasizes the importance of planning ecotourism activities based on the principle of sustainability. Establishing monitoring mechanisms and implementing science-based management measures are also essential for the sustainable protection of biodiversity.

**Keywords:** biodiversity, ecotourism, Shirvan National Nature Reserve, Caspian Sea coastal ecosystems, sustainable development

## 1. Introduction

In recent decades, the rapid loss of biodiversity has become one of the most serious environmental challenges around the world. Factors such as industrial development, intensive agriculture, urban expansion, the excessive use of natural resources, and climate change have significantly affected ecosystems and reduced their stability (Məmmədov & Xəlilov, 2006; Millennium Ecosystem Assessment, 2005). Many studies show that biodiversity loss creates not only environmental problems but also economic and social risks (Dasgupta, 2001).

Specially protected natural areas play an important role in addressing this problem. These zones play an important role in maintaining ecological balance, providing ecosystem services, and protecting endemic species (Ismayilov, 2005). The Republic of Azerbaijan's advantageous geographical location plays an essential role in ensuring biodiversity, and the protection of this natural resource has been identified as the country's number one priority (Xəlilov, 2006).

One of the most important protected regions in Azerbaijan's Caspian Sea coastal region is the Shirvan State Nature Reserve. The reserve includes different ecosystems such as semi-desert landscapes, coastal territories, and wetlands, which support a variety of plant and animal species. In particular,

protecting the population of gazelles and preserving the habitats of migratory birds are among the main conservation goals of the reserve (ETSN, 2022).

The concept of ecotourism was first introduced into scientific circulation by Ceballos-Lascuráin and explained as "a form of nature-based, ecologically responsible tourism." In Western scientific approaches, ecotourism is considered an important component of the concept of sustainable development. The concept of ecotourism is explained in the scientific literature as a form of tourism that has minimal impact on nature and that considers biodiversity conservation and environmental education as its main goals. This concept was first formulated in the late 20th century and is closely associated with the concept of sustainable development. The main idea of ecotourism is to ensure the restoration and long-term conservation of natural resources while using them (Ceballos-Lascuráin, 1996).

The main principles of ecotourism are ecosystem protection, environmental education, and participation of local communities (Honey, 2008). Buckley (2011) notes that ecotourism can only make a real contribution to biodiversity conservation if serious planning and control mechanisms are in place.

Ecotourism helps to create a responsible attitude towards nature in society through environmental education (Ballantyne & Packer, 2011). In addition, revenues from ecotourism play an important role in the protection of reserves and funding of scientific research (Eagles et al., 2002).

Involving local communities in ecotourism stimulates socio-economic development and makes biodiversity conservation a social responsibility. The impact of ecotourism on biodiversity conservation is multifaceted and encompasses ecological, social, and economic aspects. These impacts are especially evident in specially protected areas.

First of all, ecotourism plays an important role in environmental education. Visitors to the reserve are informed about the natural environment and rare and endangered species. As a result of this process, people develop a responsible attitude towards nature and strengthen ecological behavior. Ecological education is one of the main factors that has a positive impact on the protection of biodiversity in the long term.

The second important impact is related to the formation of financial resources. Eco-tourism revenues can be used to maintain reserves, do research, or repair destroyed habitats. In Shirvan Nature Reserve, such revenues would be helpful in conducting tracking of animals as well as the initiatives for increasing populations of the antelopes native to the reserve. At times, a steady source of revenue makes it possible to plan in the long term for the preservation of nature.

Nature tourism gives people an opportunity to improve the local economy and the social conditions of their settlements. When participating in ecotourism ventures, locals may increase their salaries as well as find new directions in which to work, thus improving economic conditions. With the change in approach, the protection of nature takes a new dimension since wildlife conservation becomes locals' business, not just some government project

In addition, ecotourism offers great opportunities for science to progress further. During guided hikes along paths, scientists observe the natural behavior of organisms that are not disturbed by human activity. The result of such research is a better understanding of the species' well-being based on the patterns observed. Changes that can be monitored help determine the correct action required for conservation. Information on the dynamics of changes becomes clearer due to the gentle observation of nature

Non-destructive influence is one of the most essential principles of ecotourism. The idea behind it is that no trip must lead to an ecosystem collapse or interfere with wildlife. Limitations on human activities, such as using designated routes and following rules, are important to minimize the negative impact on the environment. Such constraints distinguish small-scale travel from overcrowded destinations

Another thought which is behind ecotourism can be linked with the moral concept of nature. Moral conception suggests that people have to improve their relations with nature. Utilization of natural resources

should go together with the protection of nature. It is especially important when it comes to vulnerable ecosystems like Shirvan State Nature Reserve.

Ecotourism that is carefully developed can play an essential role in protecting natural sites on scientific principles. Money made from it often flows into better reserve facilities instead of vanishing elsewhere. Some pay for studies that track animal behavior over time. Monitoring setups also get funding where they might otherwise lack support. In addition, ecotourism also performs an ecological education function and serves to form the ecological awareness of society.

In recent years, the development of ecotourism has created new opportunities in such areas, both in terms of conservation and education. In international scientific publications, ecotourism is considered an area of activity that acts as a bridge between biodiversity conservation and sustainable development (Weaver, 2008; Honey, 2008). However, the impact of ecotourism is not unambiguous and can only yield positive results if planned on scientific grounds (Buckley, 2011).

***The main objective of the study-*** The aim of this study is to systematically investigate the impact of ecotourism on biodiversity conservation in the Caspian coastal zone of Shirvan State Nature Reserve from scientific, theoretical, and practical aspects. Within the framework of this goal, determining the role of ecotourism in preserving the ecological balance existing in the reserve area and assessing the advantages and limitations of ecotourism activities in terms of sustainable biodiversity conservation have been identified as key priorities. At the same time, the study also included an analysis of the level of compliance of the current situation in the Shirvan State Nature Reserve in comparison with successful models of ecotourism applied in international practice for biodiversity protection.

*To achieve the goal of the study, the following tasks were identified:*

- To determine the general natural and geographical features of the Shirvan State Nature Reserve and the impact of the Caspian coastal areas on ecosystems;
- To assess the current state of biodiversity in the reserve;
- To analyze the mechanisms of impact of ecotourism on biodiversity, to determine the ecological impacts of this type of activity.
- To evaluate the possibilities of implementing a sustainable ecotourism model by analyzing the methods of planning and managing ecotourism in the Shirvan Reserve;
- To determine the impact of a sustainable ecotourism model on the protection of biodiversity in the area, maintenance of ecological balance, and socio-economic development of local communities.

## 2. Research object and methods

### 2.1. Research object

- The object of the study is the natural ecosystems of the Shirvan State Nature Reserve located in the Caspian coastal zone and the ecotourism activity formed in interaction with the protection of biodiversity within those ecosystems. The study focused on semi-desert and wetland landscapes, the diversity of flora and fauna in the area, especially the gazelle population and migratory bird species.
- In addition, ecotourism routes, observation infrastructure, visitor flows, and the mechanisms of impact of these activities on biodiversity were comprehensively assessed in the reserve. In the context of the interaction between tourism and conservation activities, a systematic approach was used; the study subject was not restricted to natural elements.

### 2.2. Research methods

Modern approaches to ecotourism, the principles of ecological management, and the idea of sustainable development formed the basis of this study's methodology. In order to thoroughly analyze the subject, the

whole study used a methodical approach. To guarantee the validity of the research findings, theoretical and practical techniques were used.

Based on international scientific research, a methodology was established, which included an assessment based on government statistics and the experience gained from observations of other countries. Further, the results had to be collated and reconstructed into more detailed conclusions about the effect of natural tourism on biodiversity. Trends started to appear during extrapolation and interpolation, gradually providing broader results. Every stage was linked to reality, forming opinions based not on subjective suppositions but on objective logic.

The degree of correspondence between international models of eco-tourism and existing practices in the Shirvan Reserve was estimated using the comparative method of analysis. The application of statistical and dynamic methods made it possible to identify the condition of biodiversity and, specifically, the dynamics of the gazelle population.

The study focused on ecological risk assessment. Using this method, it was possible to identify possible ecological risks associated with an excessive increase in ecotourism activities and to suggest the best management strategies. Additionally, the idea of carrying capacity has been used to theoretically support the ideal visitor numbers in order to safeguard the sustainability of ecosystems.

The selected approach has made it possible to objectively and methodically evaluate the effects of ecotourism on biodiversity conservation, as well as to produce both theoretical and empirical outcomes.

## 3. Conclusions and analyses

### 3.1. The effects of ecotourism on biodiversity

How ecotourism is regulated in the Shirvan National Nature Reserve has a significant impact on its success. Here, ecotourism shouldn't be considered just a leisure pursuit. Additionally, it should support environmental education, nature conservation initiatives, and scientific research. Weaver (2008) believes that this method is superior for maintaining biodiversity over the long term.

According to a study, ecotourism has both direct and indirect impacts on biodiversity. Conservation receives funding, and surveillance receives increased attention. In other instances, learning becomes innovative at schools, and the economic benefits spill over to the local community (Honey, 2013).

Near the Caspian Sea, where the terrestrial ecosystem meets the marine ecosystem, changes occur rapidly when species are added or removed. The birds that migrate require such places for rest due to the easy availability of food and shelter. Considering that such changes impact ecosystems in marginal places, tourism requires sensitivity regarding natural phenomena. The relationship between living things dictates human behavior.

When people limit how many visitors enter an area, choose viewing spots carefully, yet spread out travel paths thoughtfully, nature tends to stay balanced. Ecosystems often struggle when too many show up, especially if no clear plan guides where they go.

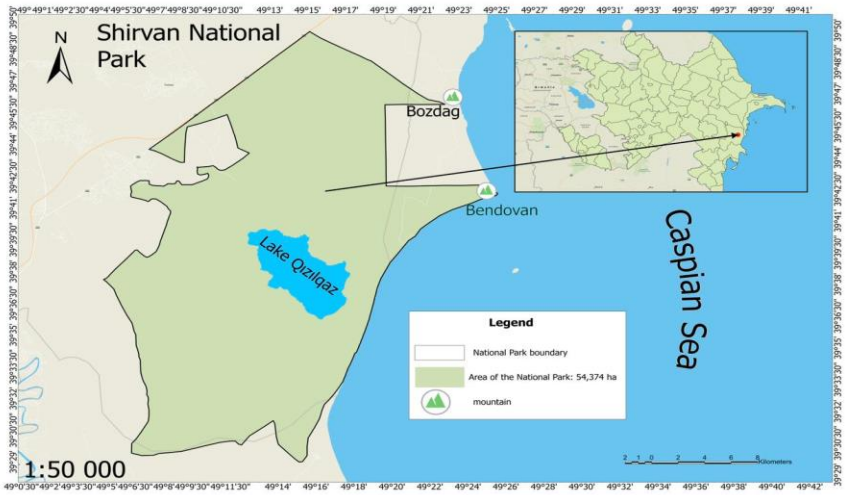


***Figure 1.*** *Schematic map of the Shirvan National Nature Reserve*

Considering the present-day problems associated with the environment, it becomes even more significant to preserve the diversity of life forms that exist in the coastal areas of the Shirvan National Nature Reserve, which lies near the Caspian Sea. Management measures, besides conservation efforts, are needed to maintain ecological balance.The Report on the ecological status of Shirvan State Nature Reserve (ETSN, 2024**)** confirms that these management strategies have been effectively implemented, ensuring that the reserve's ecosystems remain resilient against both natural and anthropogenic pressures. This official data provides a baseline for evaluating how regulated ecotourism activities interact with the current state of vegetation and wildlife

From this point of view, the concept of ecotourism plays a vital role in connecting the goals of preserving nature with socioeconomic development. By means of ecotourism projects implemented in the protected area, it is possible not only to increase the awareness related to ecology but also to manage the impact of anthropogenic influence (Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, 2019). Moreover, ecotourism contributes to maintaining biodiversity by ensuring the preservation of different types of flora and fauna.

In order to evaluate the effectiveness of ecotourism, it is necessary to compare areas with ecotourism to other areas lacking it.

***Table 1****. Ecotourism events in the Shirvan Reserve*

| **Indicators** | **Without ecotourism** | **When ecotourism is applied** |
|---|---|---|
| State of vegetation | High risk of trampling and degradation | Security measures are strengthened, and vegetation is protected |
| Number of animal species | Likelihood of decline due to poaching | Due to increased monitoring, the number of species remains stable or increases. |
| Bird colonization | Displacement and decline due to disturbance | Monitoring zones are being established, and birds are being protected |
| Human impact | Uncontrolled access, litter | Activity is regulated by routes and rules |
| Attitude of the local population | Remaining outside the reserve | Be interested in conservation by earning income from ecotourism. |
| Sustainability of biodiversity | Long-term risk | Continuous and controlled protection |

### 3.2. Potential risks

In attempts to preserve fauna, ecotourism may adversely impact nature itself – according to researchers, lack of proper planning results in damage (Buckley, 2004; Buckley, 2011; Weaver, 2008). One such peril involves human disruption of the natural behaviors of the wild creatures. Disturbances from noise, tourists' activity, transport, and humans themselves might disrupt their schedule. This can lead to considerable stress in sensitive and endangered animals (Steven et al., 2011). In particular, gazelles are believed to be at risk in the Shirvan reserve.

Plant damage occurs frequently enough. Uncontrolled walking and trampling on plants results in erosion of the soil and, consequently, harm to plants. On the Caspian seacoast, vegetation and soil barely survive under pressure.

Lack of waste management may become rather problematic. With more tourists coming to the area, the amount of garbage increases, thus posing risks to contamination of the earth and rivers. Though often overlooked, the link between travel growth and environmental strain shows clearly here.

Socioeconomic risks should also be taken into account. Local communities may become discontent if the advantages of ecotourism are not distributed equitably, which might undermine support for conservation initiatives (Honey, 2013). Moreover, the effectiveness of ecotourism initiatives may be hampered by inadequate laws, inefficient control mechanisms, and a shortage of qualified employees, which are all examples of poor governance (Eagles et al., 2002).

There are a number of recommendations in the scientific literature on how to lower risk:

• Limit the number of visitors

• Clearly mark ecological trails

• Create initiatives to raise awareness of environmental issues

• Use ongoing monitoring systems (Buckley, 2011)

Therefore, if ecotourism is carried out scientifically and with institutional support, it may have a beneficial effect on biodiversity. The utilization of sustainable ecotourism principles in the reserve is essential for the conservation of biodiversity.

### 3.3. Gazelle population dynamics (1961–2025)

Shirvan Reserve is one of the main protected areas established in Azerbaijan for the protection of gazelles (Gazella subgutturosa). Long-term monitoring shows that the gazelle population has had positive dynamics since the second half of the 20th century.

• According to initial observations conducted in 1961, the number of gazelles in the reserve was 77. Uncontrolled hunting and anthropogenic impacts have led to a decline in the population.

• After the official establishment of the reserve in 1969, conservation measures were strengthened, and the number of gazelles reached 400.

• In the mid-1980s, the population increased to 4,800 as a result of systematic protection and feeding conditions.

• During the establishment of the Shirvan National Park in 2003, a relative stabilization was observed in the population, with the number reaching approximately 4,500 individuals.

• According to 2025 estimates, the average number of gazelles in the reserve and adjacent areas is 6,500 (Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, 2015–2024).

• This indicator confirms the strategic importance of the reserve in protecting rare and endangered species.

**Table 2.** *Dynamics of the gazelle population in the Shirvan Reserve, 1961–2025*

| Year | Gazelle population (estimated) | Note |
|---|---|---|
| 1961 | ~77 heads | A small population before the reserve's protection began. |
| 1969 | ~400 heads | Protective measures began with the establishment of the reserve. |
| 1983 | ~4 800 heads | The effects of conservation measures are increasing. |
| 2003 | ~4 500 heads | Transition to the National Park stage. |
| 2025 | ~6 000-7 000 heads | Sustained growth based on recent monitoring. |

### 3.4. Sustainable ecotourism model in the Shirvan Reserve

The sustainable ecotourism model ensures the balancing of ecological, social, and economic objectives in specially protected areas. In Western scientific literature, sustainable ecotourism is considered a management approach that ensures the long-term conservation of ecosystems and contributes to the well-being of local communities (Weaver, 2008). The application of this model in the Shirvan State Nature Reserve is important in terms of biodiversity protection.

One of the main principles is to plan ecotourism activities according to their carrying capacity. Carrying capacity refers to the number of visitors an area can accommodate without disrupting its ecological balance (Buckley, 2011). The coastal regions and wetlands of the Shirvan Reserve are extremely vulnerable to human interaction; visitor numbers must be controlled according to the time of year and particular routes.

Paths that follow natural landscapes form a key part of responsible travel focused on nature. Thoughtful layout helps protect plants and animals, at the same time offering people better chances to observe wildlife up close. In places like the Shirvan Reserve, these paths could pass through shoreline zones, areas where gazelles live, or spots ideal for watching birds. Careful planning, along with signs that guide clearly, lowers the chance of accidental damage to surroundings - according to research done by Eagles and others back in 2002.

Nowhere is tracking more vital than in caring for nature long-term. Without steady observation, judging ecotourism's true impact stays out of reach - this comes straight from UNEP. In the Shirvan Reserve, watching how plants and animals change over time matters deeply. Especially fragile creatures need close attention again and again. All this was highlighted clearly in 2020 by the same source.

Community involvement is equally important. Involving local people in ecotourism activities ensures the protection of nature while improving their living conditions. Local people in Shirvan participate in the management of the program, provide services, and educate tourists. Employment opportunities emerge through such roles, while nature conservation becomes more pronounced (Honey, 2013; Ballantyne & Packer, 2011).

Environmental education transforms tourists' behaviors while traveling. Some locations provide tourists with environmental education in the form of exhibits, classes, or information boards to make better decisions in conserving the environment (Ballantyne & Packer, 2011). International experience shows that the successful implementation of a sustainable ecotourism model requires institutional cooperation. Coordination between government agencies, non-governmental organizations, and research institutions increases the environmental effectiveness of ecotourism. Strengthening these cooperation mechanisms in the Shirvan Reserve can ensure the long-term sustainability of ecotourism (Kulakova, 2019).

Consequently, the sustainable ecotourism model in the Shirvan Reserve is of strategic importance in protecting biodiversity. The joint application of scientifically based planning, monitoring, local community participation, and environmental awareness mechanisms ensures the real and sustainable contribution of ecotourism to maintaining the ecological balance of the reserve.

## 4. Conclusion

The study shows that ecotourism plays an important role in biodiversity conservation in the Caspian coastal zone of the Shirvan State Nature Reserve. The reserve's location between semi-desert and coastal ecosystems provides unique biodiversity and requires scientifically based management.

Properly planned ecotourism:

• Directs financial resources to scientific monitoring and restoration activities in protected areas;

• Ensures the protection of rare and endangered species of flora and fauna;

• It indirectly impacts biodiversity by increasing the ecological knowledge of visitors.

• It serves long-term sustainability through social and institutional cooperation.

At the same time, uncontrolled development of ecotourism can pose a risk to biodiversity: excessive visitor flow, disregard for carrying capacity, and unplanned expansion of infrastructure have negative consequences for flora and fauna. Therefore, the development of ecotourism should be accompanied by strict environmental regulation and monitoring mechanisms.

Overall, the implementation of scientifically based and sustainable ecotourism in the Shirvan Reserve can make a real contribution to both the preservation of ecological balance and the implementation of sustainable development strategies at the national level.

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