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SYNERGETIC APPROACH TO THE ANALYSIS OF THE DYNAMICS OF THE POPULATION OF THE MUSBERRY POPULATION IN THE CONDITIONS OF THE ARAL REGION

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A B S T R A C T	K E Y W O R D S
The article discusses the results of a synergistic approach to the analysis of the dynamics of the muskrat population in the conditions of the Aral Sea region. The destabilization of the ecosystems of the Southern Aral Sea, in particular, the violation of the hydro regime, one way or another, affects the population of the muskrat. Under the influence of permanent or temporary action of various external perturbations in a non-equilibrium state, detailed equilibrium does not exist.	environmental conditions, Aral Sea region, population dynamics, population, stability.

Introduction

Currently, one of the urgent problems of modern population ecology is the study of the organization and dynamics of communities of terrestrial vertebrates in a dynamically changing environment. A detailed analysis of the main structural and functional parameters of communities makes it possible to study biodiversity, which implies a qualitative and quantitative composition, species richness and dominance structure, stability, and susceptibility to disturbances in different ecosystems [2, 3].

The processes occurring in animal populations, on the one hand, are closely related to environmental conditions (climate, soil, vegetation, predators, the state of the food supply, etc.), on the other hand, are determined by the biological characteristics of the population itself (species, demographic structure, nutrition , intensity of reproduction, population dynamics, etc.). The endo- and exogenous factors affecting the population can cause changes in both the phase portrait of the behavior of the population and the intensity of the population processes occurring in it. The interaction of external and internal factors affecting population dynamics introduces an element of randomness and can cause complex behavior that determines the type of both seasonal and long-term population dynamics, and the existence of self-organization processes allows us to consider it as a complex nonequilibrium system [15, 12].

Various types of interaction between animals and their environment have developed historically in the process of evolution and ultimately reflect the trends in the optimal use of the entire complex of external conditions with equally full realization of the population's capabilities [2, 6, 20]. It is known that within the framework of a deterministic approach alone, the problem of the emergence and existence of population dynamics cannot be solved. An analysis of the reasons for the variability in the demographic and spatial structure of the population of small mammals can only be carried out using the theory of complex systems, which is able to detect the general patterns of phenomena and processes in complex nonequilibrium population systems, taking into account the principles of self-organization inherent in them [2, 8, 11].

Another reason is non-equilibrium population systems that are able to carry out bifurcation transitions to new states, thereby ensuring the stable viability of the population. After the transition to each new trajectory, it is necessary to estimate the relative stability of the most probable states, as well as the time spent by the system in their vicinity. This problem can also be solved only within the framework of an extended description that takes into account the influence of perturbations. However, for a wide class of dynamic population systems, random behavior can also arise due to the bifurcation of unstable regimes, leading, for example, to chaotic attractors. For this reason, the probabilistic description becomes a necessary addition to the deterministic approach, which makes it possible, for example, to identify the frequency of visiting different regions of a chaotic attractor [15, 12].

The main goal of the work is to analyze the probabilistic and deterministic components of the long-term dynamics of the population size of Ondatra Zibethica in the conditions of the South Aral Sea region based on the principles of a synergistic approach.

In the South Aral Sea region, the muskrat does not breed throughout the year. In the conditions of the lower reaches of the Amu Darya, muskrat breeding lasts 6-6.5 months. The average number of embryos per female may indicate the size of the broods. The size of the litter does not vary significantly over the years - from 7.1-7.8 [13, 14, 16].

In the lower reaches of the Amu Darya, on average, there are 9.8 embryos in the first litter, 8.8 in the second, and 7.7 embryos in the third. The lowest litter rate was recorded in young females of the first litter of the current year - 5.5 embryos. According to experts, in the summer period (June-August), all captured overwintered female muskrats were pregnant or had already given birth. The percentage of lethargy and resorption of embryos are very rare and amount to 0.5-0.7%. The mass appearance of the second generation is noted in the second half of June, the third generation - at the end of July-August [16, 17].

Больше информации: various Various types of interaction between animals and their environment have developed historically in the process of evolution and ultimately reflect the trends in the optimal use of the entire complex of external conditions with equally full realization of the population's capabilities [2, 6, 20]. It is known that within the framework of a deterministic approach alone, the problem of the emergence and existence of population dynamics cannot be solved. An analysis of the reasons for the variability in the demographic and spatial structure of the population of small mammals can only be carried out using the theory of complex systems, which is able to detect the general patterns of phenomena and processes in complex nonequilibrium population systems, taking into account the principles of self-organization inherent in them [2, 8, 11].

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The intensity of the reproductive processes of the muskrat is stable in water bodies with a constant food supply. On the territory of the Khorezm region, females with 5-6 embryos (about 45-50%) are most often found, in the lakes of Karakalpakstan, about 4-5 embryos are observed in the litter on average. The size of the litter varies slightly over the years, 4.3-4.5. However, the decisive factor that determines the intensity of reproduction and population dynamics is the state of water bodies and their water supply throughout the year, the availability of food and protective resources, and places for building dwellings. In recent years, the natural conditions of the delta of the lower reaches of the Amudarya have changed dramatically, anthropogenic desertification is taking place, numerous lakes and swampy habitats are drying up, degradation of reed and cattail thickets is observed. According to scientists, the sex ratio in newborn individuals of the early litter is almost the same (49.0% of females and 51.0% of males). The marked predominance of males in spring is explained by their activity during the breeding season [8, 9].

At present, in the Amudarya delta, internal and peripheral lakes (Lake Akchakul, Zhyltyrbas, Muynak Bay, Karateren, etc.) and some small reservoirs, the total useful area of which is about 20 thousand .ha During the breeding season, as is known, the age structure of the population changes significantly, which is a consequence of changes in the intensity of reproduction of muskrats of different ages. In turn, the age composition determines subsequent reproduction and population size. The coefficient of variability in the proportion of females among age groups ranges from 60% to 89%. The results obtained by the harmonic mean method (Fig. 1) largely confirm the regularity.

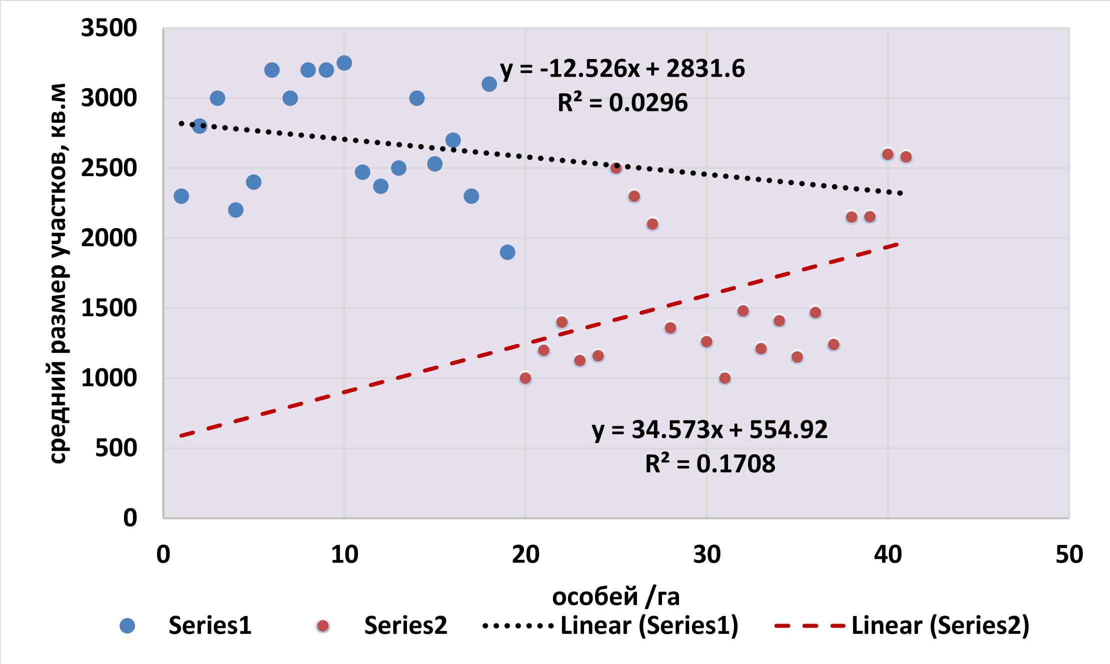

Fig.1. Dependence of the average sizes of individual sections of the muskrat population

The exception is the average values of the sizes of plots at "ultra-low" population densities. Judging by the graphs, it can be assumed that at low values of the muskrat population density, a positive, possibly also hyperbolic, relationship is observed between the average sizes of individual plots and the muskrat population density. Although sites determined by the harmonic mean method cannot be fully considered individual sites in the conventional sense, they nonetheless adequately characterize the presence of individuals at the trapping site.

The analysis showed that the coefficient of variation among breeding females was also the highest for the age of 1-8 months. The most stable proportion of breeding females older than 2 years, the coefficient of variation is small - 1.85%. The coefficient of variability in the number of males in different age groups is very high and reaches up to 107%. This indicates that males undergo significant changes during the reproductive period. We also note that the age ratios in the total annual catch are completely dependent on the intensity of population reproduction and change in accordance with the dynamics of environmental conditions. Deterioration of watering of lands and drying up of lakes leads to their qualitative transformation and reduces the yield of young animals.

A comparative analysis of the population dynamics of Ondatra Zibethica (Fig. 2) and the runoff dynamics of the river. Amu Darya (Fig. 3) showed the existence of a relationship between these two processes, where the trend lines indicate that both processes tend to decrease. At the same time, it is necessary to note the discrepancy between the maxima. This can be explained by differences in the nature of fluctuations in the number of muskrats and the flow of the Amudarya River. In the first case, these are natural fluctuations in the population size inherent in this species, in the second case, the fluctuations are of a climatic nature.

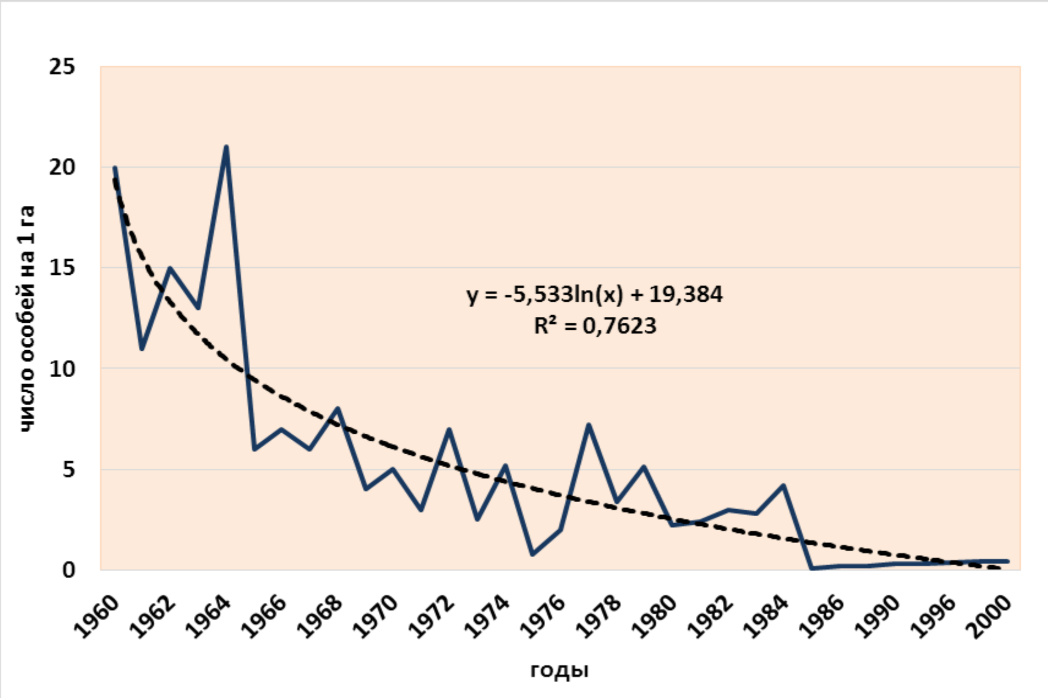

Fig. 2. Dynamics of the muskrat population and its trend (dotted line)

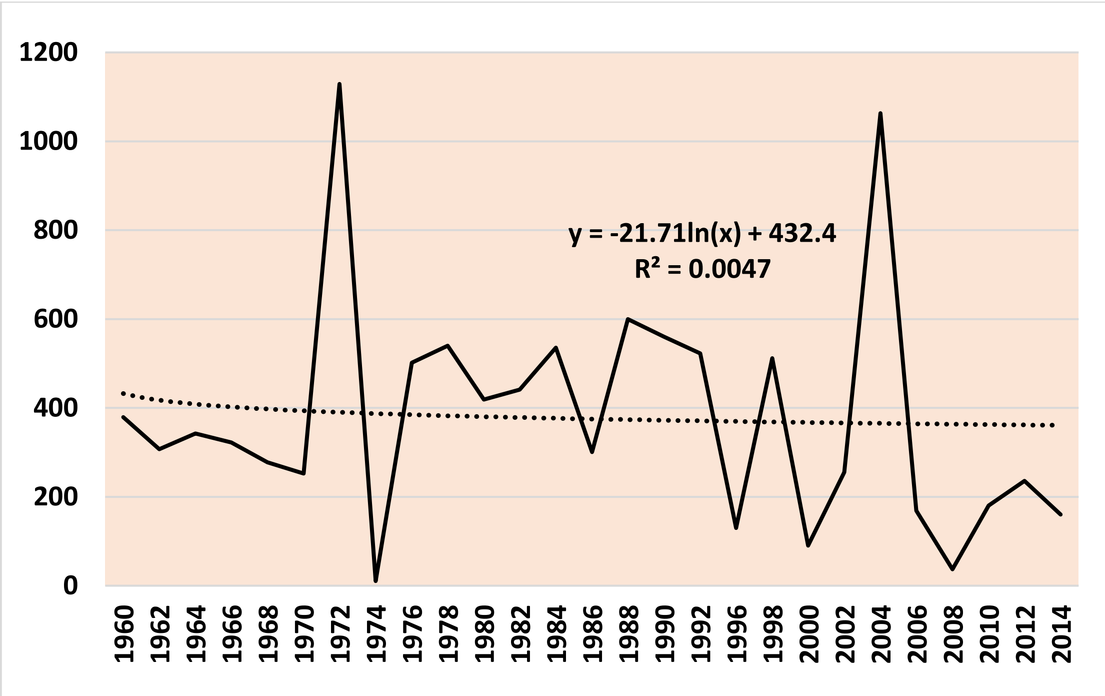

Fig. 3. Long-term dynamics of the Amudarya runoff and its trend (dashed line)

The lack of response of the muskrat population to abrupt short-term changes in river runoff, even with a time lag, indicates that the dynamics of the Amudarya runoff is not the main, but a background factor in the dynamics of the muskrat population. Nevertheless, a rather high correlation of these series was revealed: $\rho=0.56$.

As a result of the work carried out aimed at maintaining collector-discharge lakes and creating new reservoirs in the fore-delta, fed by river and collector-drainage waters, the total area of reservoirs has

increased significantly [19]. Thus, the living conditions of the muskrat improved, which led to an increase in its numbers, starting from 2002. The Amu Darya is the main factor for vegetation that quickly responds to low water [1], and the population of Ondatra Zibethica responds the next year.
The long-term set of probabilities for the implementation of long-term population dynamics is statistically significant ($\chi 2 = 5.8$) and is described by an asymmetric log-normal distribution, shifted towards low abundance (Fig. 4). Such interval distributions are usually characterized by series with rare random events.

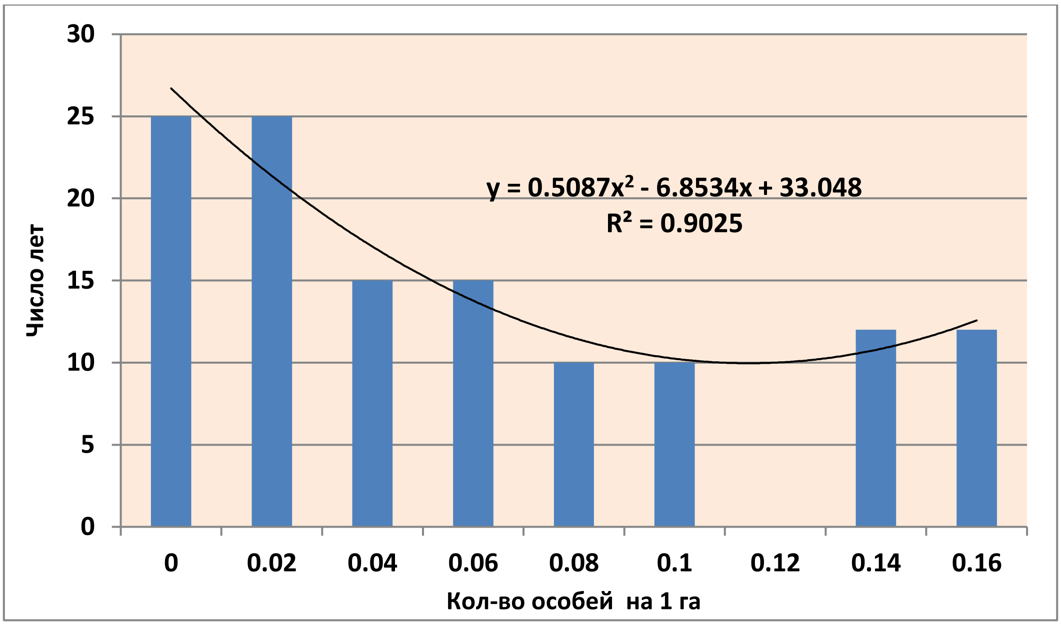

Fig. 4. Probability distribution of numbers in a long-term series of observations.

Therefore, the dynamics of the studied population, which is a sequence of transitions from one state to another, can be classified as stochastic, and the corresponding process can be classified as Markovian, since the period the animals are in a certain state is a random continuous value [3, 5].
After each breeding season, a specific population of wintering animals is formed, the fate of which is determined by the processes that took place during the entire spring-summer period. Depending on the overwintering conditions, the spring population will be either low or high, which largely determines the population dynamics of the next year [6, 7].
In general, we observe that the destabilization of the ecosystem of the South Prearalie, in particular, the violation of the hydro regime, one way or another, affects the size of the muskrat population. It can be assumed that the attenuation of natural fluctuations in the abundance of mesophilic animal species (for example, the muskrat) under conditions of an unstable ecosystem is typical. Under the influence of permanent or temporary action of various external perturbations in a non-equilibrium state, detailed equilibrium does not exist. This property underlies the ability of nonequilibrium population systems to carry out bifurcation transitions to new states, ensuring the viability of the population.

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