Description of Population Cycles of Wood Grouse
(*Tetrao urogallus* L., 1758) through Long-Term Monitoring

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Abstract—The paper discusses he dynamics of the cycles of long-monitored (1971–2012) wood grouse population inhabiting the experimental unit of the All-Russia Research Institute of Game Management and Fur Farming, as well as the dynamics of the cycles of 12 other populations in the Novosibirsk region that were subject to monitoring from 2000 to 2012. The population sizes were estimated using annual walk-through surveys conducted according to uniform methods. The chronograms were tested for latent harmonic components. The districts involved in the walk-through survey were attributed the spectra of population dynamics and evaluated in terms of periods and the power of the harmonic components of each spectrum. It was identified that the spectrum of the population dynamics was comprised of eight pronounced harmonic components differing in amplitude and power; the most powerful components referred to periods of 4.5 and 14.9 years. The relationship between the rate and the power of the dynamics of the wood grouse population cycles differs depending on the district of the Novosibirsk region. Moreover, there is a trend of increasing durations of low-frequency cycles in the northern direction. The sites inhabited by wood grouses feature natural environmental rhythms that can influence (prolong) the population cycles of this species.

Keywords: *Tetrao urogallus*, population size, cyclicity, period, spectrum of periodic changes, cycles, periodic changes, fluctuations

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INTRODUCTION

Population dynamics is the main focus of population ecology. Different mechanisms of this dynamic process have been suggested. Ecologists and physiologists examine different physiological and biochemical processes in species at different phases of population size (Christian, 1980; Krebs, 1996; Chernyavskii and Lazutkin, 2004; Rogovin and Moshkin, 2007). While changes in population sizes spark considerable interest in the context of long-term monitoring, so do cyclical processes associated with the complex curve of the dynamics. We are concerned with periodic components in the long-term dynamics. It is the superposition of these internal periodic changes that yields the comprehensive image of population size variations over time. While the last century has been marked by intense arguments about the cyclical and noncyclical dynamics of populations (Erdakov et al., 1990), the cyclical nature of population dynamics is no longer doubted today (Beletskii, 1992; Chernyavskii and Lazutkin, 2004).

In this study, we focus on the population characteristics and describe regular changes in population size determined by internal factors. Such a description does not require analysis of biological processes (physiological and biochemical). The degree of adaptation of the population can be assessed by its chronoeological structure.1 The population can adapt to any external periodic changes through synchronization (prolongation of its own periodic changes). In other words, a stable population cycle is supposed to be independent, since its mechanism is based on the internal population process(es); i.e., the external geophysical periodic changes are synchronized (Maksimov, 1984). Otherwise, adaptation becomes impossible: if there is no internal specific frequency, nothing can be synchronized with external periodic processes. The cycles of dynamic processes are not difficult to identify and specify. This has already been achieved for numerous animal populations (Maksimov, 1984; Erdakov, 2011).

In the course of studying the population size of wood grouse in the Novosibirsk region, special attention was...
paid to cyclical characteristics. Our goal was to find the periodic components of the population size dynamics of wood grouse. The objectives were as follows:

— to identify the spectrum of periodic changes in population size typical of this species;
— to estimate the duration and intensity of the harmonic components of the population dynamics;
— to find probable external synchronizers for different cycles of the population dynamics of wood grouse;
— to identify the differences in cyclical changes typical of species associated with a specific area in the Novosibirsk region.

MATERIALS AND METHODS

The material used was data on the population size of the species obtained as a result of the walk-through surveys. The walk-through surveys were undertaken in the territory of the experimental unit of the All-Russia Research Institute of Game Management and Fur Farming (Fig. 1) in the Kyshtovka district of the Novosibirsk region (southern taiga subzone; 57°06′55″ N and 77°18′03″ E) in November over 42 years (1971–2012). The surveys were conducted in conformity with uniform methods (Semenov-Tyan-Shanskii, 1964; Metodicheskie ukazaniya..., 1980). The annual distance covered by the survey was no less than 500 km. In addition, we analyzed data on the population dynamics of wood grouse from 12 different districts of the Novosibirsk region (Fig. 1) collected on annual walk-through surveys over 12 years (2000–2012) in compliance with standard methods (Metodicheskie ukazaniya..., 1990).

To perform calculations, we used spectral analysis software owned by the Institute of Animal Systematics and Ecology of the Siberian Branch of the Russian Academy of Sciences. The spectral power density was estimated by the Welch method (Marple, Jr., 1990). All calculations were conducted with GNU Octave freeware (http://www.gnu.org/software/octave/; http://ru.wikipedia.org/wiki/GNU_Octave), written in a high-level language. The system uses an interactive command line interface and makes it possible to solve various linear and nonlinear mathematical problems (http://www.gnu.org/software/octave/; http://ru.wikipedia.org/wiki/GNU_Octave). In particular, the pwelch function from the Octave-Forge extra package (http://octave.sourceforge.net/signal/function/pwelch.html) was applied to estimate the spectral power density with the Welch method.

To make things simpler for users, a special interface was designed. This interface features an interactive mode for data exchange and all processing operations, including the choice of size and number of windows, graphical presentation of data, etc.