LITHUANIAN ACADEMY OF SCIENCES
INTERNATIONAL CENTRE FOR SCIENTIFIC CULTURE - WORLD LABORATORY
LITHUANIAN BRANCH

ECOLOGICAL SUSTAINABILITY OF LITHUANIA

(ECOSLIT)

1994 Annual Report (abstract)

III

Vilnius, 1995

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State Scientific Project

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1995, Kovas

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6. SUSTAINABILITY OF SPECIES AND POPULATIONS: CONCEPTUAL APPROACH AND DATA ANALYSIS

R. Volskis, T. Bitvinskas, V. Žiliukas, A. Mickus, A. Burba

6.1. Parameters defining the functioning of species and their ecological sustainability

The conception of the regularity of species functioning in time and space formulated in 1987 by R.Volskis has been detailed further on. At present several parameters enabling to characterise the change of vitality of species in time and space are already known. There has been clearified the relation of the fluctuations of vitality and abundance of the concrete species according to hydrological, cosmic, climatic and other cyclically recurrent processes of different duration. The data presented are on the change of the abundance of 4 species of water animals in Lithuania and outside it during the period of 10 years. The following 4 species of water animals of inner waters of Lithuania were selected for investigations : ondatra-mammal, pike and bream-fish, crawfish-invertebrate. From higher plants, the pine has been investigated. The ecological optimum zone (EOZ) of each species and the biotops optimal to it in Lithuania was determined. Specific gravity of the populations of these species (SGP %) was caculated. Later on all data were compared with long-term hydrologic and solar activity cycles as well as with climatic changes.

The analysis performed by J.Jablonskis in 1993 on the hydrometeorologic data during the period of 100 years including the flow showed that cyclical fluctuations of longer duration are characteristic to their long-term change. The first break of fluctuation in 100 years period took place in 1825-1830, the second - 1870-1880, the third - 1935-1940. The Nemunas flow of the first fluctuation phase (up to 1830) was 3.1 % larger than standard, of the second phase (1830-1875) - 4.2 % lower than standard, of the third phase (1876-1936) - 3.6 % larger than standard. Since 1937 the Nemunas flow decreased by 3 %.

It was shown that the regularity of species functioning in time and space was proved as well by the data on the change of yearly increment of pine in the distribution area (T. Bitvinskas, 1991). Solar activity models (SA) exhibiting 11, 22, 44 and 88 year cycles were compared to the relevant period of radial increment in trees. It was determined that during 22 and 44 year cycles during some phases of SA the pessimums and optimums of radial increment of trees in turn are concentrated. They can obviously be different in their degree of pronouncement and length. They depend on geographical region, sites of growth, tree species, degree of exposition and altitude.

It has been determined that the atmospheric and soil pollution even more strengthens the negative extremal factors influencing the increment of trees, their vitality, health. It is important to stress that during the last years (1992-1994) the rings of trees became particularly narrow (Fig. 6.1). Therefore, most unfarourable years for the economy of Lithuania, are mainly taking place during the phases of fall and minimum of SA. In such a way having analyzed the influence of cyclic processes on yearly increment of pine we will generalize the results of the investigation of water animals.

6.2. Distribution area and dynamics of bream catch

The bream is spread almost in the whole Europe (in the lakes of the basins of the North, the White, the Black, the Caspian, the Azov and the Aral Seas, rivers and water

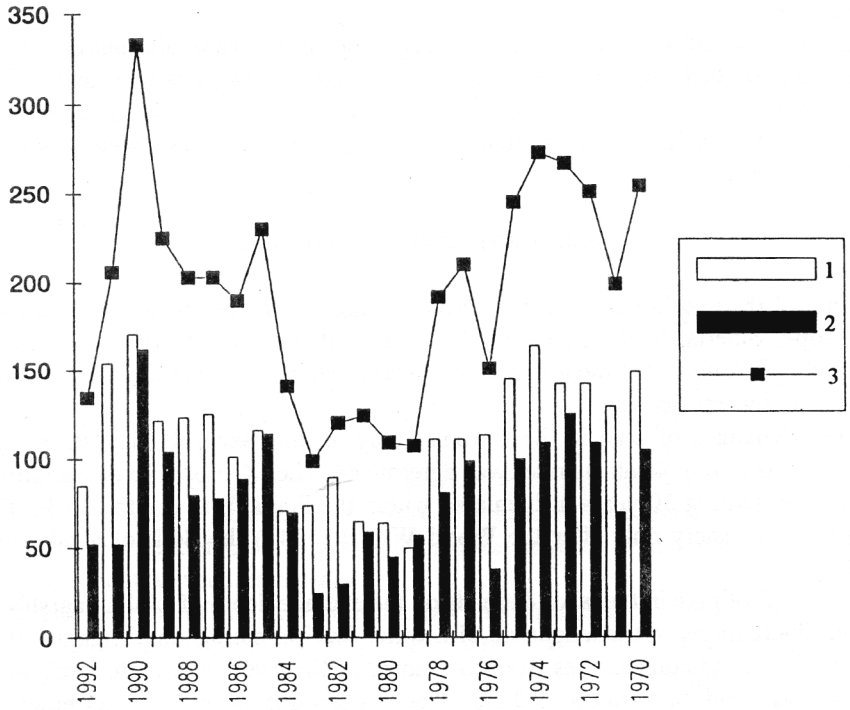

Fig. 6.1. The dynamics of the yearly increment of scoch pine (Pinus sylvestris) in Neringa: 1- yearly wood, 2 - late wood, 3 - annual ring

deposits). The bream was acclimatized in the West Siberia. It inhabits many lakes, water deposits and larger rivers in Lithuania.

In order to determine the ecological significance of the species it is necessary to be aware of its production within the frames of its distribution area. The part of the production of the whole area used by a man in one year period was suggested to name the production from the distribution area. The official statistical data on catches of fish are not absolutely precise. In fact, the harvest is much bigger. However, the long-term statistical data reflect the dynamics of the abundance of fish or other resources of animals under the conditions of intensive exploitation. To our opinion, the statistics includes about 70 % of catches of bream in fresh waters and 90 % - in seas.

With the increase of water eutrophization in Lithuania the resources of bream during last 30 years increased. The breams, caught in lakes, rivers and water deposits make from 7.6 to 24.2 % of general catch. According to the abundance of freshwater fish in general catches, the bream is the third.

The species as an ecological unit functioning in time and space is characterized by one of the main parametres - specific gravity of population (SGP %) in communities. A certain SGP level is peculiar to the populations of every species. As a rule, SGP reaches its highest significance in the zone of ecological optimum of the species in a certain geographical latitude and longitude, in a certain climat, the type of ecosystem and the biotype peculiar to this species. SGP as well as some other parametres are regularly changing in time and space. Not only the highest percent of SGP is peculiar to the species in the zone of ecological optimum.

In this zone the individuals of this species differ in their exterior, growth speed and reproductiveness.

On the basis of primary data on the bream populations from different distribution areas it has been determined that the growth rate of bream, the average weight and age reach the maximum of the ecological optimum of species in the geographical latitude in the Deno river basin. The optimal conditions for bream in Lithuania are shallow lakes covered by water plants and the Curonian Bay.

6.3. Distribution area of pike

Natural distribution area of pike is very large. This species is spread almost in the whole Europe, Siberia, in the basins of the rivers and the lakes of the Aral Sea, in North America. Pikes belong to the most frequently spread fish in Lithuania. It is found almost in all lakes, rivers and water deposits.

SGP dynamics of pike in the Curonian Bay, in the lakes of Alaušas, Avilys, Sartų, Dysnų as well as in the Nemunas river was determined. The SGP of pike in the Curonian Bay is rather stable. During 30 years it fluctuated within the limits from 0.7 to 7.4 %. During the whole history of fishery only after the World War II (1947) the SGP of a pike was higher (16.0 %).

The SGP of pike in the lakes depends on the average depth of a lake, marshly shores as well as the fluctuations of the amplitude of a water level in spring. Investigating the SGP of the young pike in the communities from the shores of the rivers it was determined that their SGP in average did not exceed 3.3 %. The populations of pike in different points of distribution area differ in maturity, exterior of the body and growth rate. The maturity age of pike fluctuates from 1 to 6 years.

The rule of the zone of the ecological optimum suits very well to pike, as well. The analysis of the data from the database of freshwater fish indicates that in EOZ the growth rate and other parametres of a female pike are relatively high and increasing to the South. Pike is growing more rapidly in Lithuania than bream. Though the SGP (%) of pike is much lower than that of bream.

The average yearly SGP of pike in the water bodies of Lithuania makes 1-3 %, whereas that of bream makes 20-24 %. The catches of pike are decreasing, whereas of bream are increasing.

6.4. Dynamics of crawfish in Lithuania

At the end of the 19th c. and the beginning of the 20th c. there was a lot of crawfish (A. astatus). The data on crawfish catchings were analysed at separate stages. During 1890-1914 only average catches were presented – 2500 cnt. per year. During next stage in 1924-1940 the catches of crawfish increased up to 2040 cnt. and in 1940 the catches decreased to 250 cnt. Most of crawfish caught up to 1940 were exported. A part of caught crawfish, no doubt, was used in the local market, but this is not shown in statistics. During the other stage in 1945-1965, the catches still were high, and in 1950, 1954, 1955 and 1956 they reached 300 cnt. From 1957 up to 1965 a part of crawfish was exported, in 1961-1964 there were exported 14-39 cnt of crawfish (A. leptodactylus). During the period from 1966 up to the 70-ies the catches of crawfish decreased. In 1969 and 1971, the catches made only 40-30 kg of crawfish. Since 1970 the catches of crawfish in Lithuania started to increase only due to A. leptodactylus.

A number of crawfish in one area unit and a number (kg/ha) of commercial crawfish were calculated considering only the inhabited area of crawfish. The average catches of crawfish in different water bodies indicated the abundance of crawfish caught per year as well as the distribution of water bodies inhabited by crawfish. The largest production of crawfish was caught in the lake of Rūgštis - 28.6 kg/ha, in the lake Lamėstas during 1963 there were caught 15.1 kg/ha, in the lake Persvėtas - 16.1 kg/ha. In the large lake Dringis (725.9 ha) in 1954 there were caught 0.03 kg/ha, though in the other large lake Ilgis there were caught 5.1 kg/ha, in the lake Obelijos - 3.1 kg/ha. The data on the catches of crawfish show that crawfish in Lithuania is rapidly disappearing.

6.5. Introduction of ondatra and its catches in Lithuania

The results of the introduction of ondatra (1954 and 1956) were successful. The reproductiveness and the productivity of ondatras is inversely proportional to the density of the population. When there is a high density a number of generations is decreasing, while the density is low a number of generations is greater. However, this dependence does not influence the dynamics of abundance because the influence of environmental factors is stronger. The environmental factors in principle predetermine the sexual and age structures of the population of ondatra in separate years.

The rapid increase of the distribution areas and the quantity of crawfish in the inner waters of Lithuania caused a lot of new phenomena. New relations were formed when ondatras appeared in these biocoenosis as ondatras fed themselves on plants and animals. But on the other hand ondatras were fed on to the other beasts.

* * *

In conclusion, let us underline that, there is a very distinct decrease of catches of the three species (pike, crawfish, ondatra) in the lakes of Lithuania. Only the catches of bream since 1950 have increased.

When analysing the dynamics of the population of one of the species in several water bodies of the same thermal type it is possible to see the influence of the hydrologic and climatic factors as well as the impact of solar activity cycles on water animals.

The general tendencies of the change of the abundance of the species are as follows:

a) A. Astacus in Lithuania is a rapidly disappearing species. The main reason is the increase of the average yearly water acidity, the increase of temperature, the decrease of a water level as well as the process of eutrophization;

b) the eutrophization of water bodies influenced the increase of the resources of bream and its catches;

c) the resources of pike are limited by the amateurish fishery;

d) the abundance of ondatra has reached its maximum in about 1971-1975, i. e. 20 years after its introduction in Lithuania. At present the former ecological niche is changed because a lot of water plants have been destroyed. The abundance of ondatras has decreased considerably.

While investigating the resources it is expedient to pay more attention to the analysis of the dynamics of the abundance of separate species of plants and animals, determining the zones of ecological optimum of model species and the limits of production and other parametres in optimal biotops of Lithuania. The conception of the ecological sustainability may be concretized when investigating vitality of model species characterizing the change of parametres in time and space.