



УРАЛЬСКИЙ НАУЧНО-ПРАКТИЧЕСКИЙ ЦЕНТР РАДИАЦИОННОЙ МЕДИЦИНЫ Urals Research Center for Radiation Medicine

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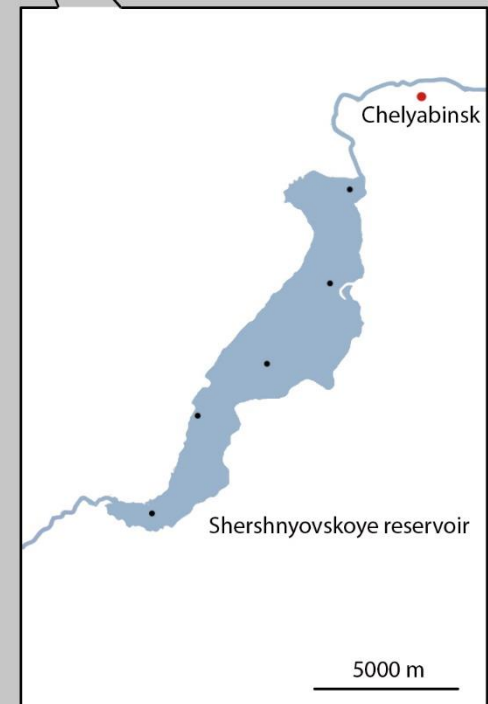
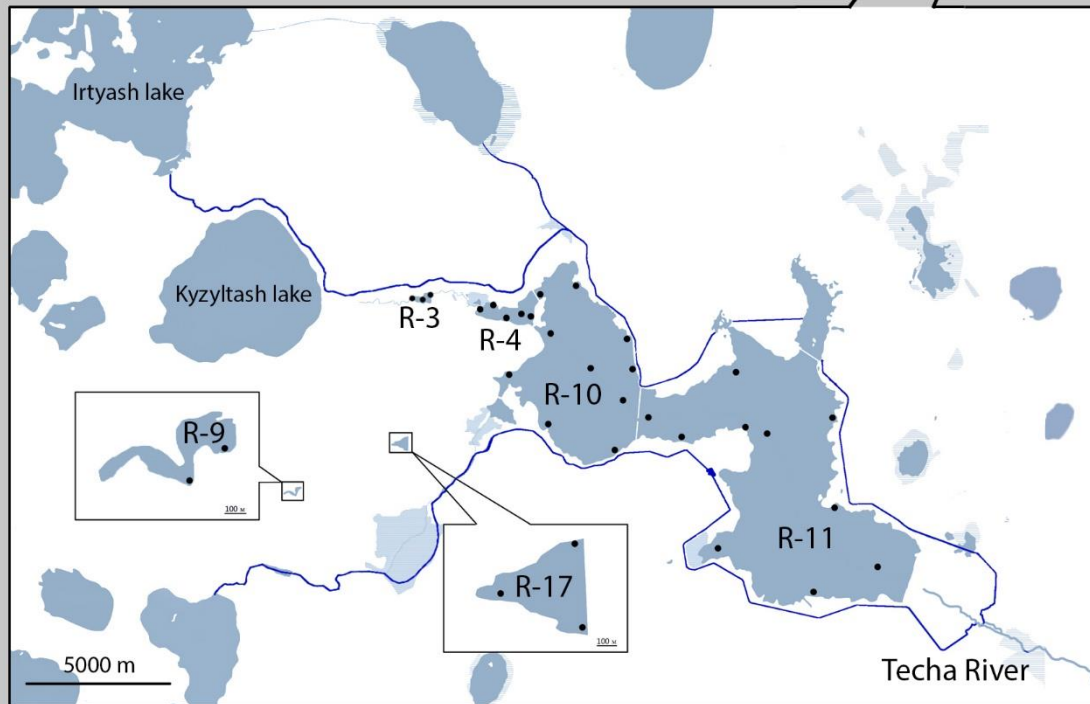
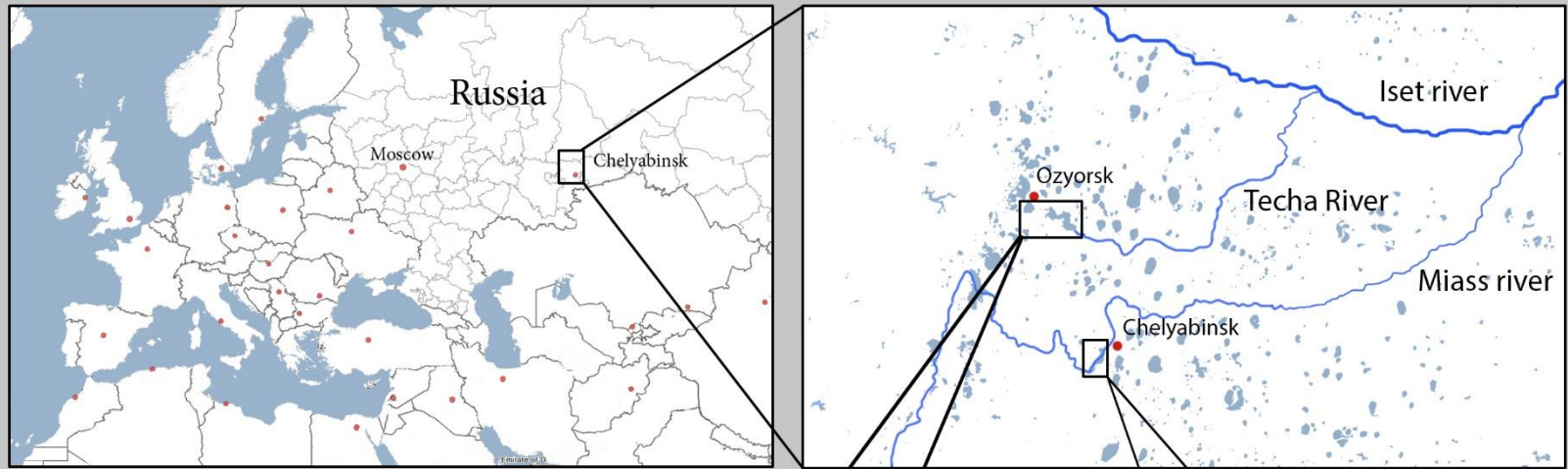
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REACTION OF WATER BIOCEANOSES TO CHRONIC RADIATION EXPOSURE

Location of reference and the PA «Mayak» industrial reservoirs. Dots in the figure mark sampling stations on the studied reservoirs



Design of water ecosystems investigation

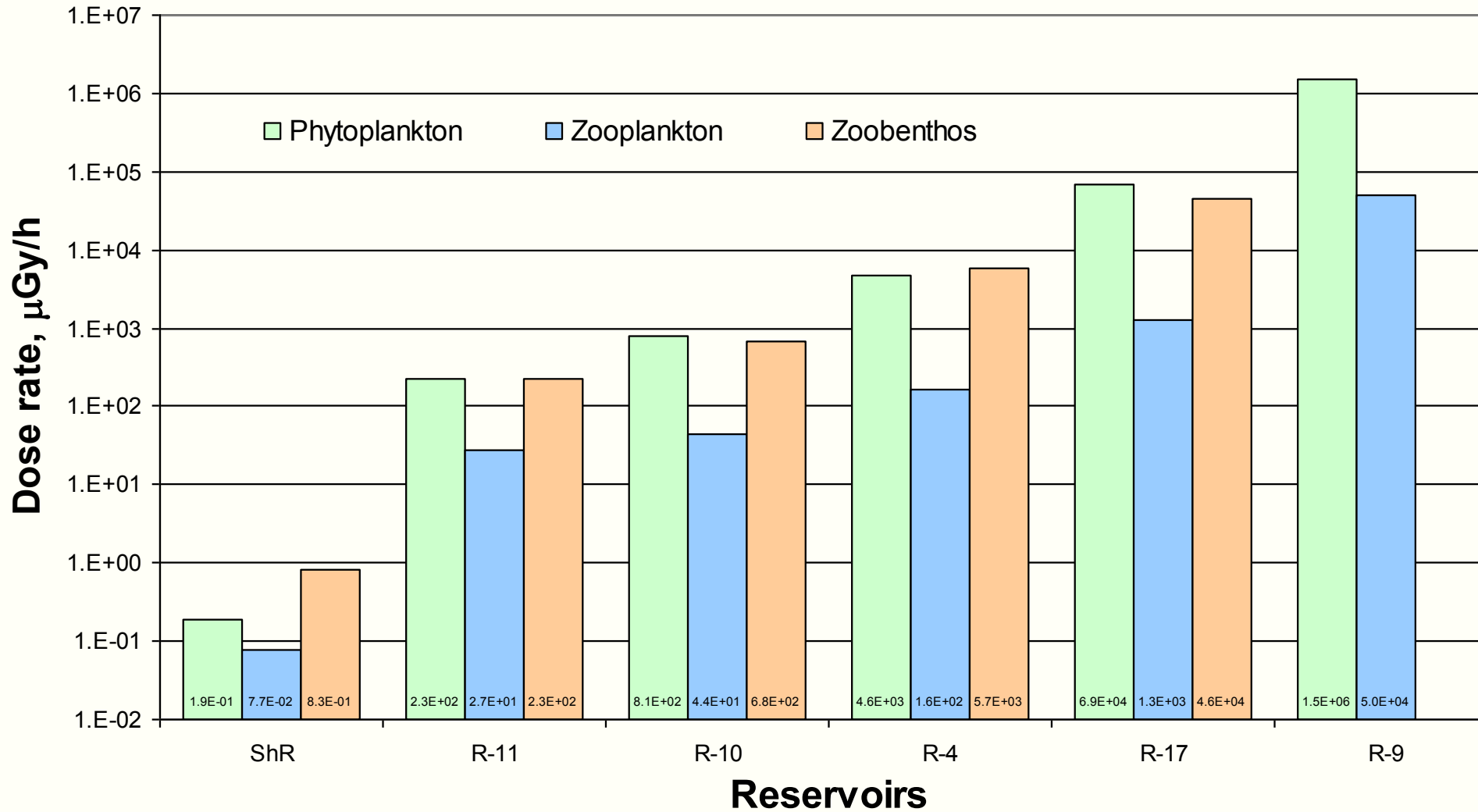
1. Chemical analysis of water.
2. Determination of radionuclide content in water, sediments, phytoplankton, zooplankton, zoobenthos.
3. Dosimetric investigations.
4. Study of phytoplankton species composition, abundance, biomass.
5. Study of zooplankton species composition, abundance, biomass.
6. Study of zoobenthos species composition, abundance, biomass.

Main characteristics of the studied reservoirs

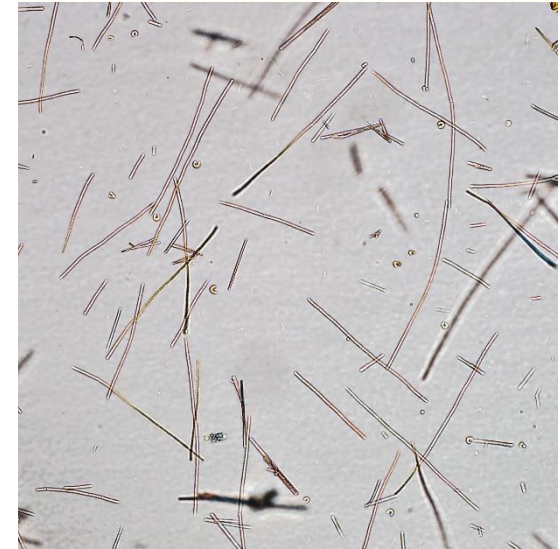
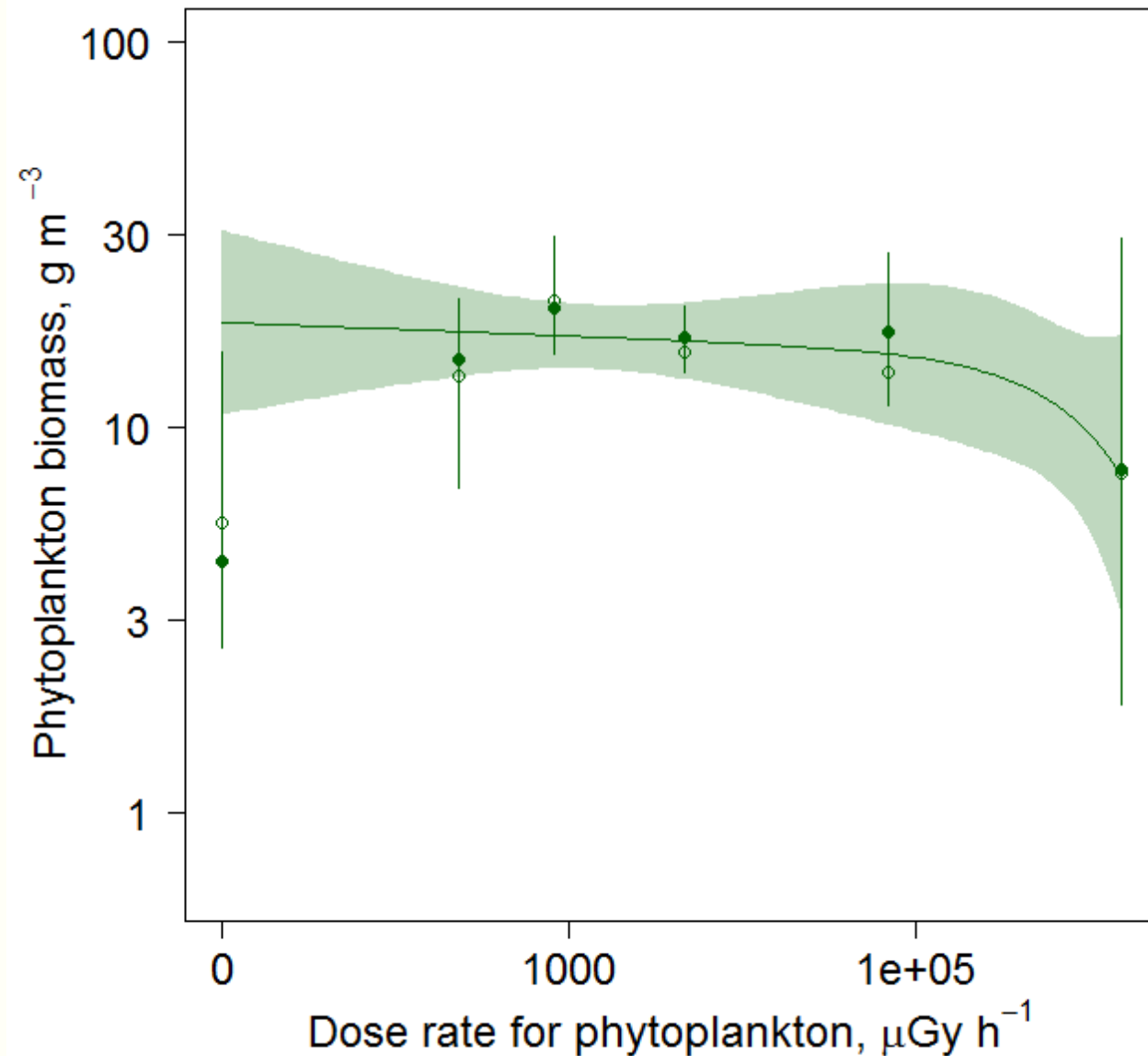
Parameters	¹ ShR	² R-11	² R-10	² R-4	² R-17	² R-9
Year of reservoir creation	1965	1965	1956	1951	1949	1951
Water-surface area, km ²	39.1*	44.2*	18.6*	1.3*	0.13	†0.07
Maximum depth, m	14*	12.3*	9.3*	3.5*	6.5	5.2

Note: ShR - Shershnyovskoye reservoir; *values of the parameter at normal maximum operating level. ¹(Pryakhin et al, 2010). ²(Malyshev et al, 1997). † Data 2005 for reservoir R-9. (Alexakhin et al. 2007)

Estimated values of the dose rate for hydrobionts, $\mu\text{Gy/h}$ (Erica Assessment Tool)

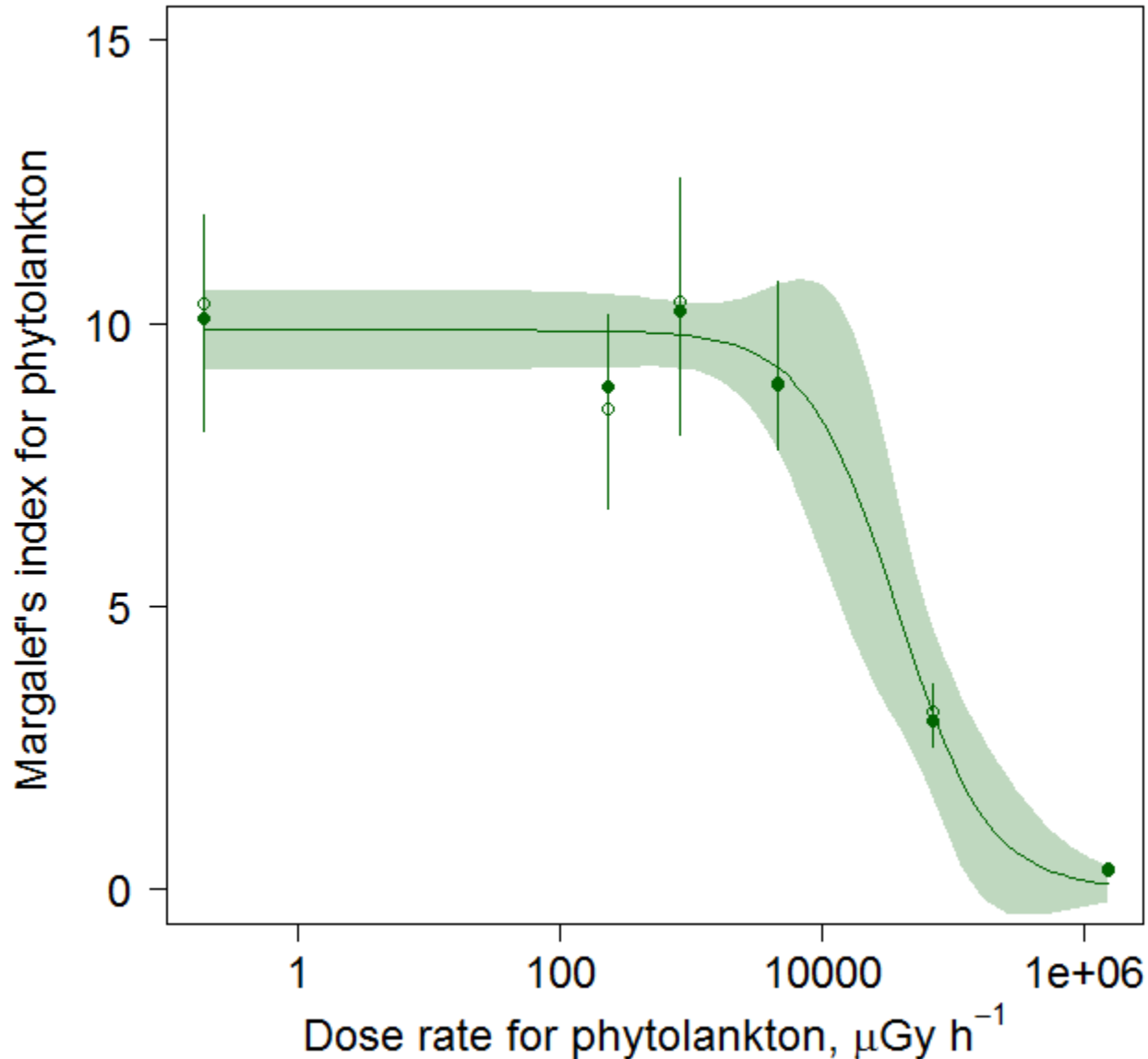


Dependency of phytoplankton biomass on dose rate



- - Mean; ● - Median
- | — - 0.25 – 0.75 quantiles
- - Regression line

Dependency of Margalef's index for phytoplankton on the dose rate



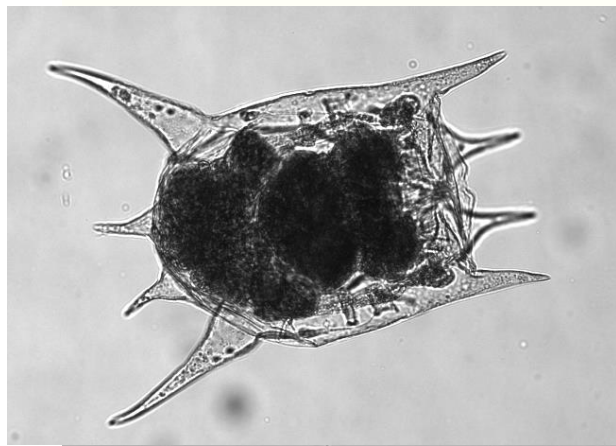
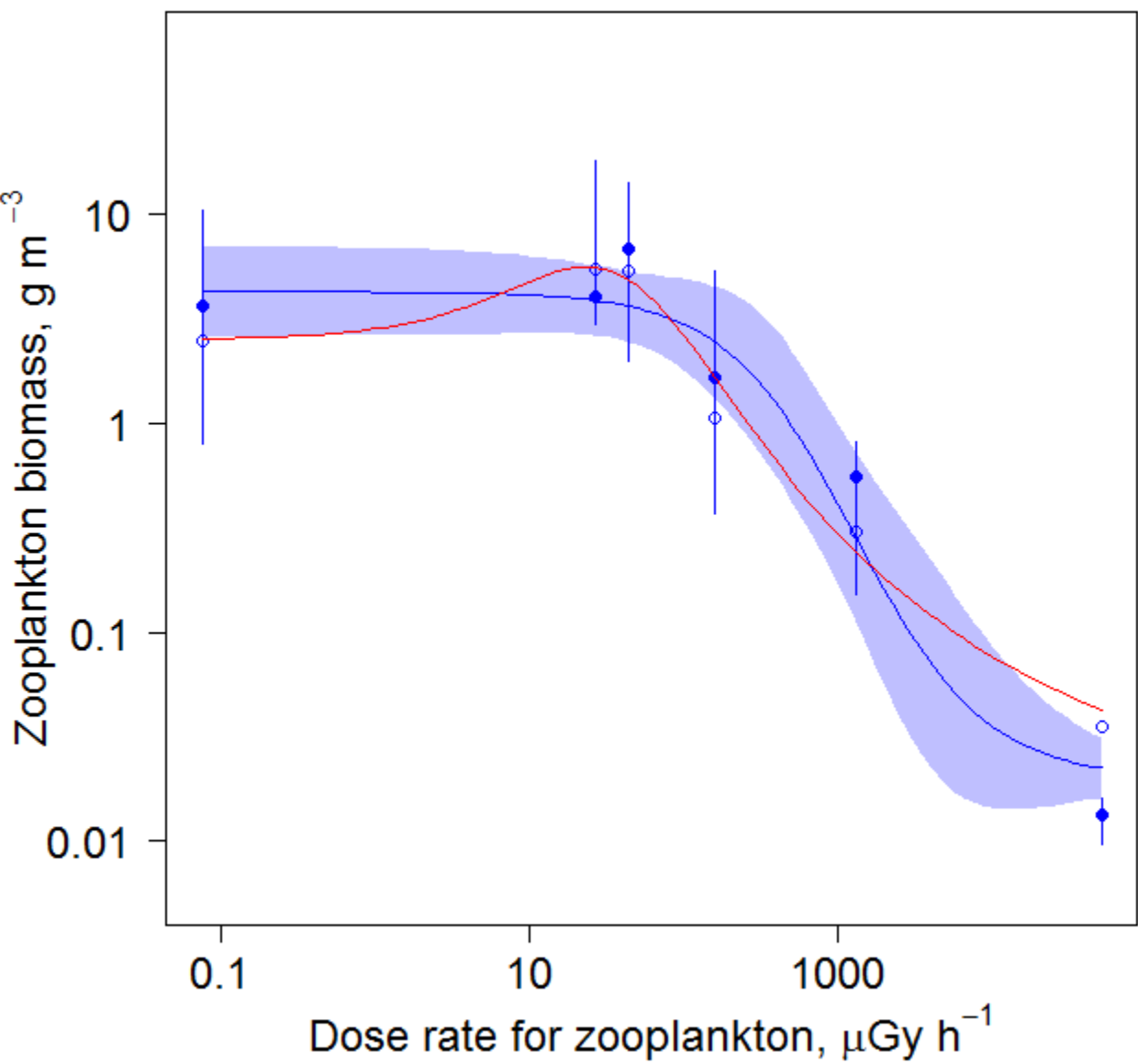
D_{Mg} - Margalef's diversity index

$$D_{Mg} = \frac{(S - 1)}{\text{Lg}N}$$

Where N = the total number of individuals in the sample and S = the number of species recorded

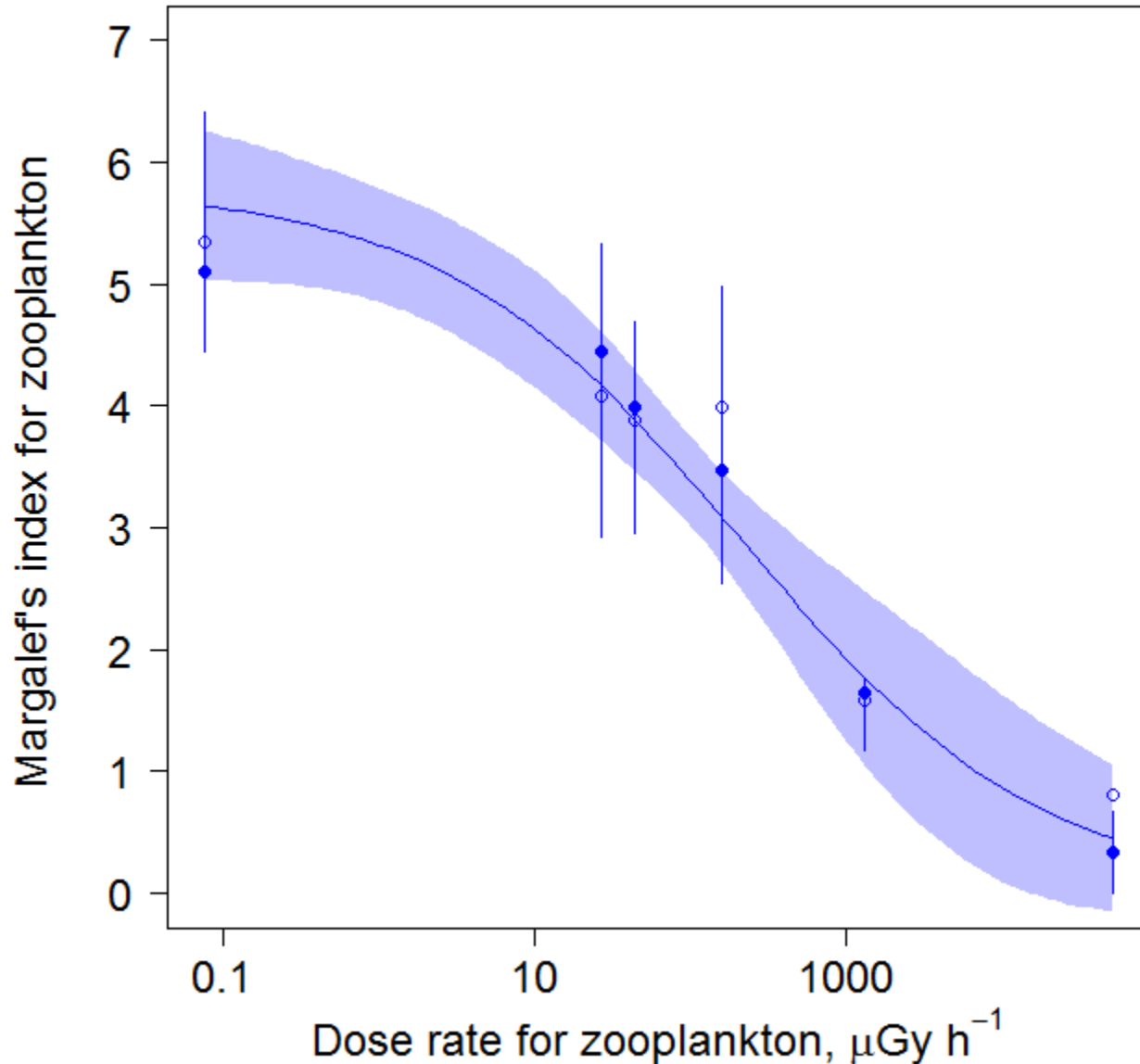
- \circ - Mean; \bullet - Median
- - 0.25 – 0.75 quantiles
- - Regression line

Dependency of zooplankton biomass on dose rate



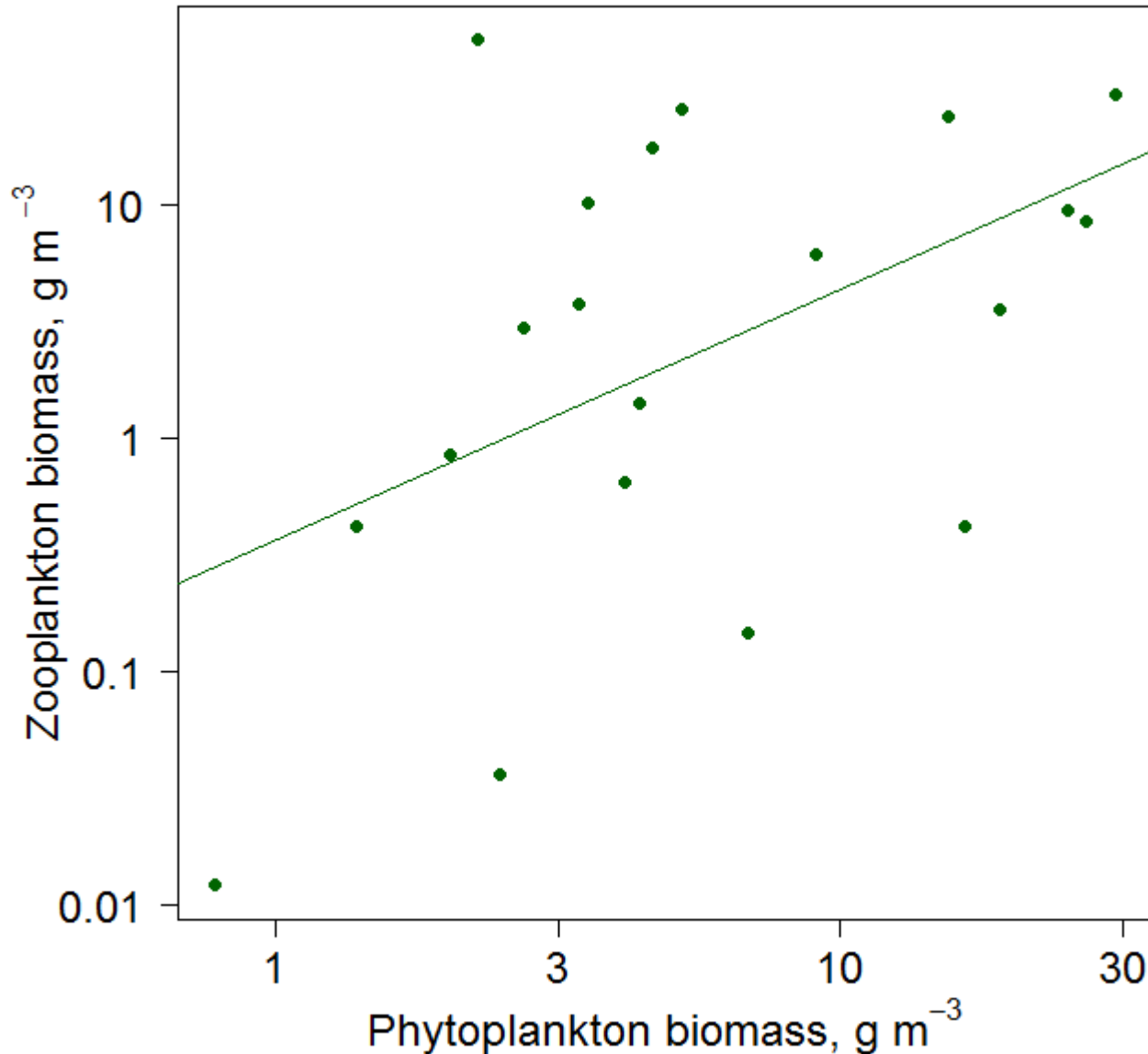
- - Mean; ● - Median
- | - 0.25 – 0.75 quantiles
- - Regression lines

Dependency of Margalef's index for zooplankton on dose rate

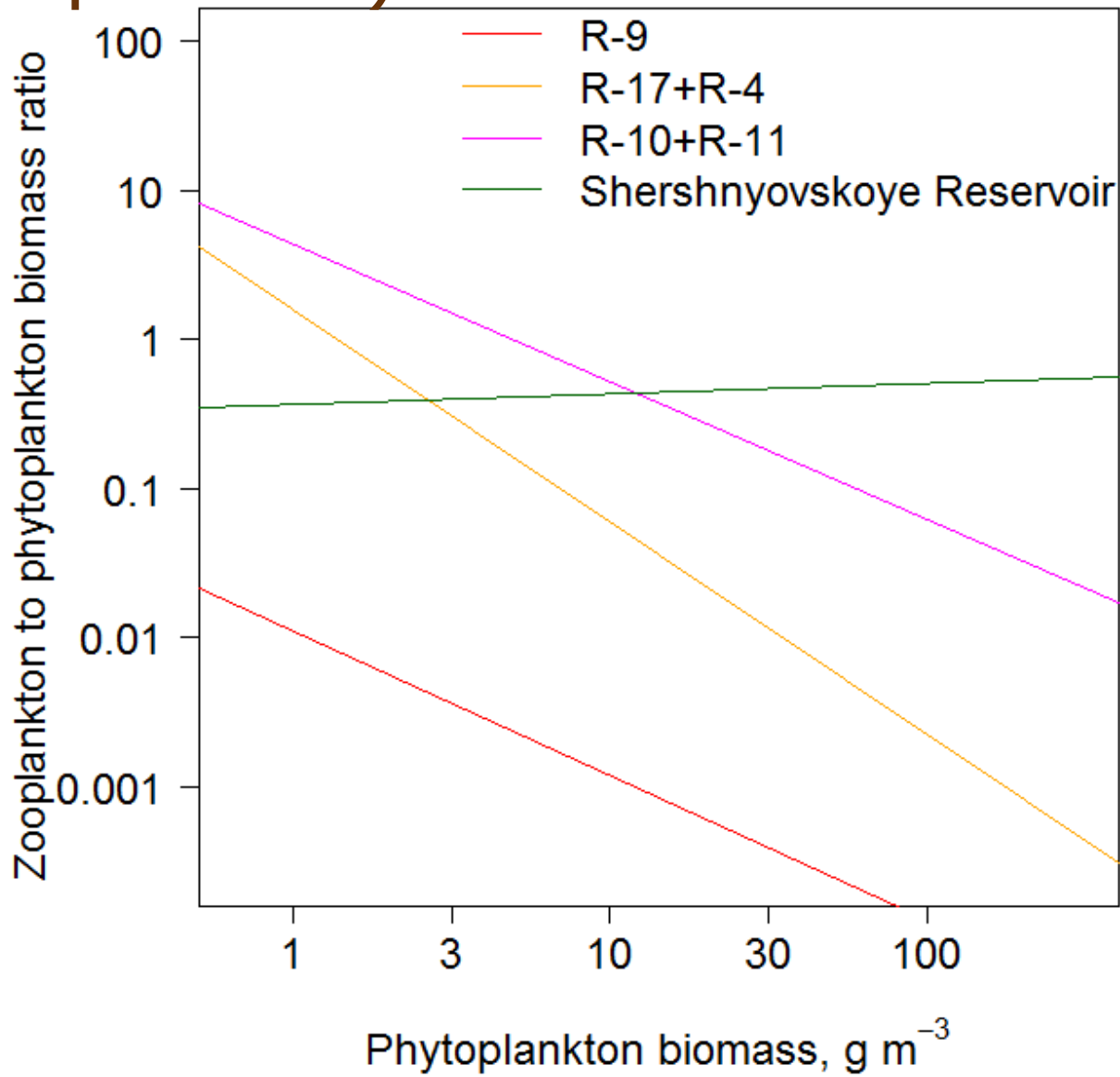


- - Mean; ● - Median
- | - 0.25 – 0.75 quantiles
- - Regression lines

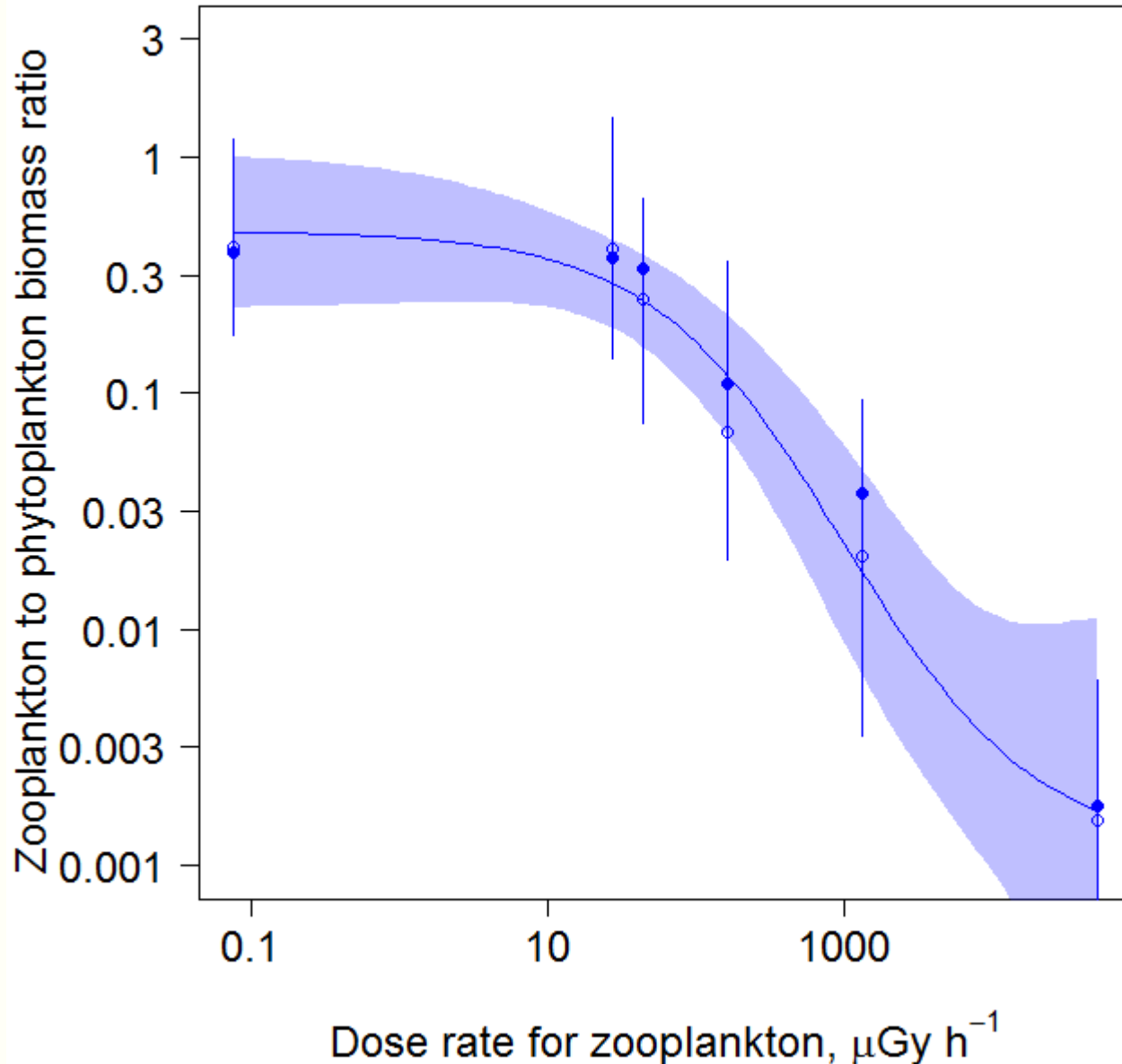
Dependency of zooplankton biomass on phytoplankton biomass in samples for comparison reservoir



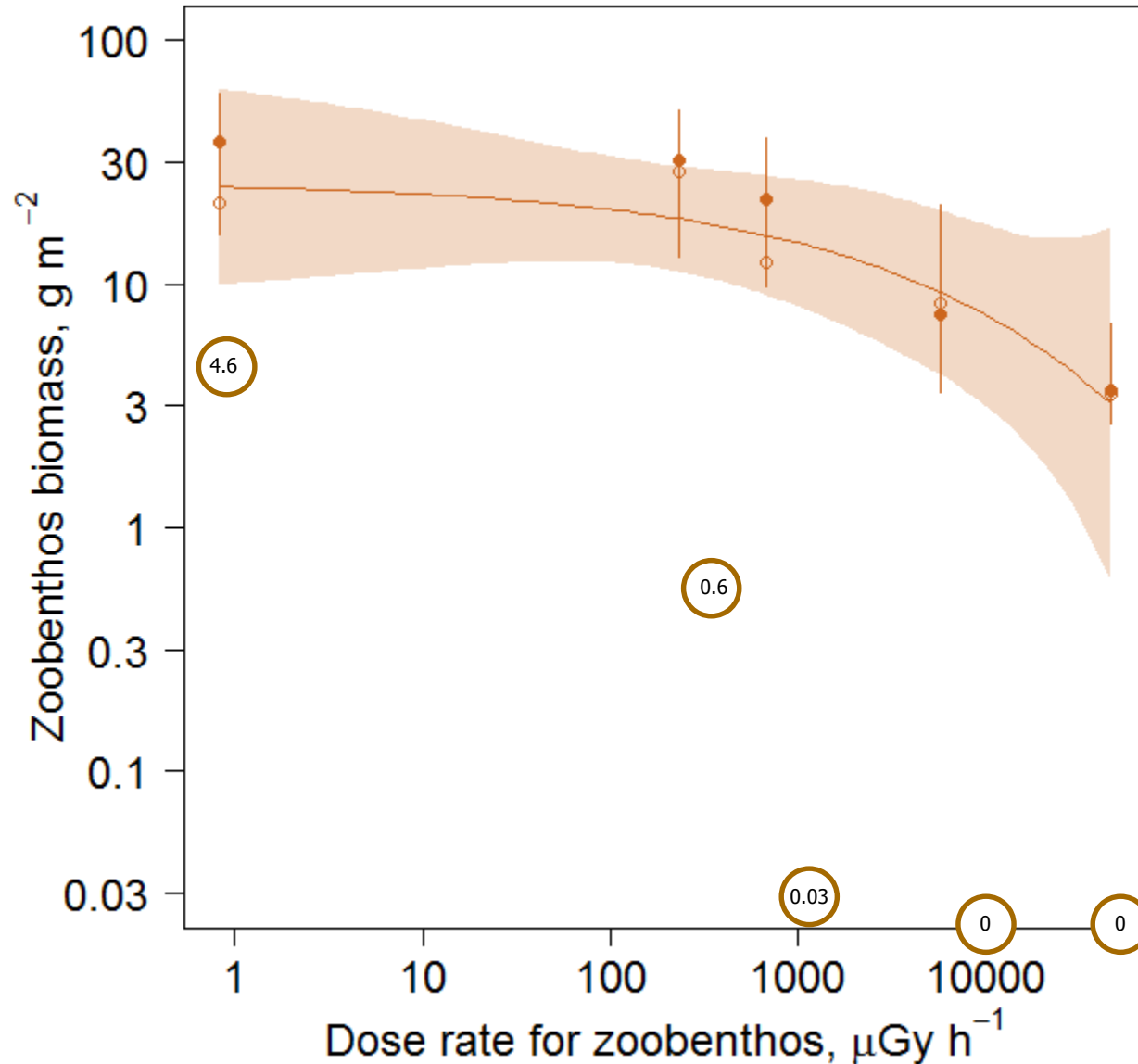
Biotic (trophic) interactions of primary producers and primary consumers (phytoplankton-zooplankton) in the studied reservoirs



Dependency of the index of the trophic interactions of consumers and producers (zooplankton biomass to phytoplankton biomass ratio) on radiation exposure dose rate

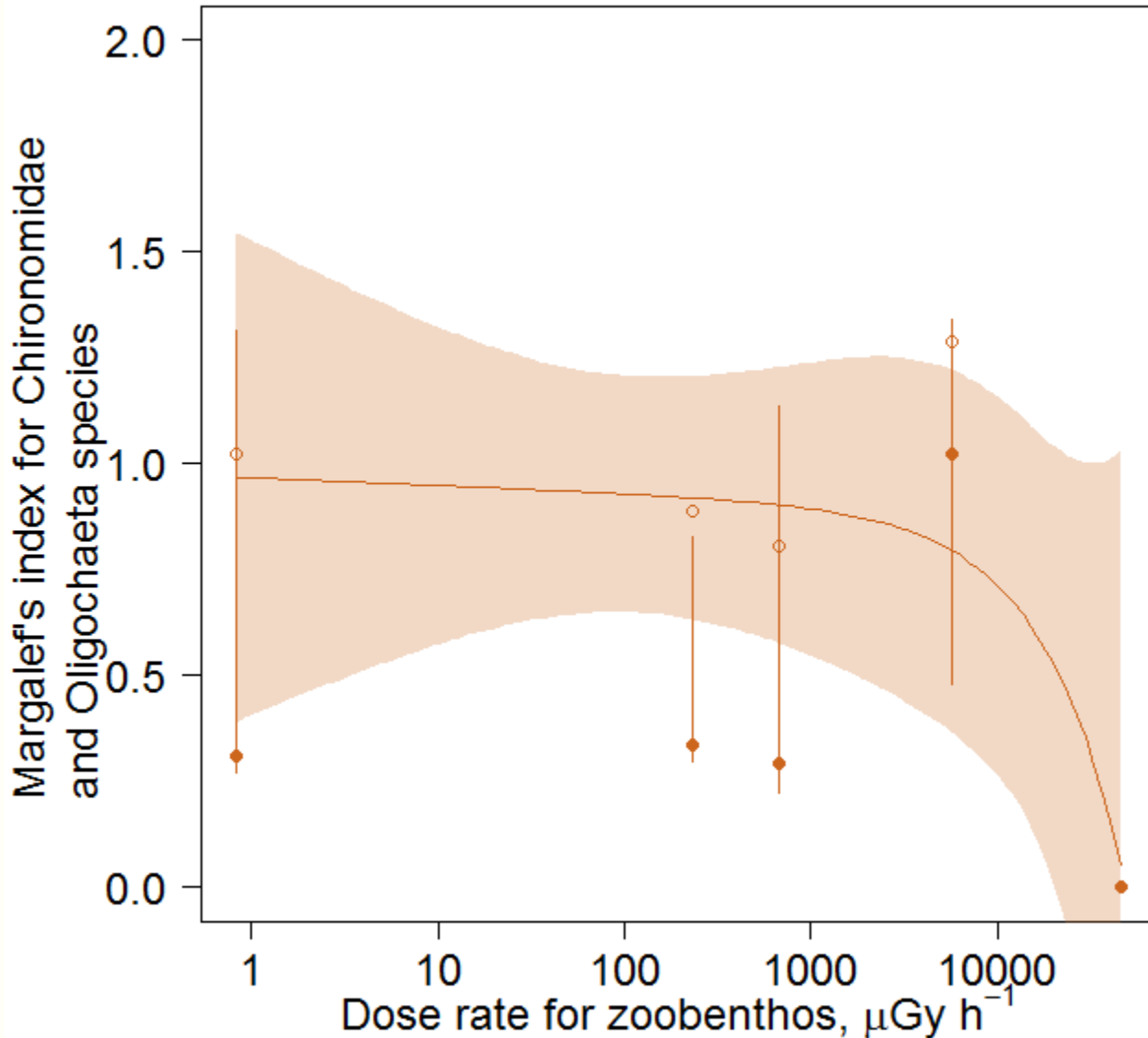


Dependency of zoobenthos biomass on dose rate



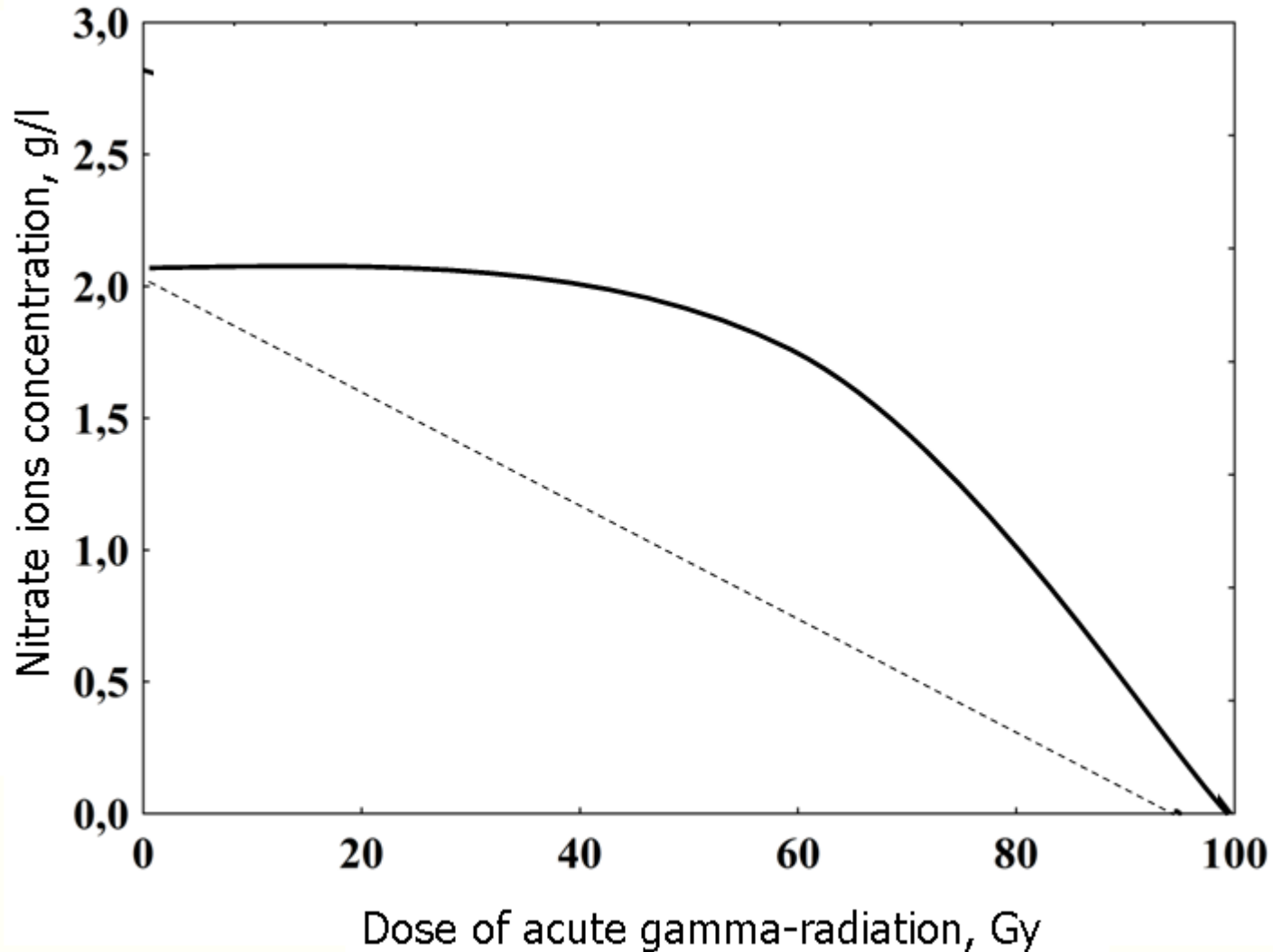
- - Mean; ● - Median
- | - 0.25 – 0.75 quantiles
- - Regression lines
- - Bivalves biomass

Dependency of Margalef's index for zoobenthos (chironomidae and Oligochaeta) on dose rate

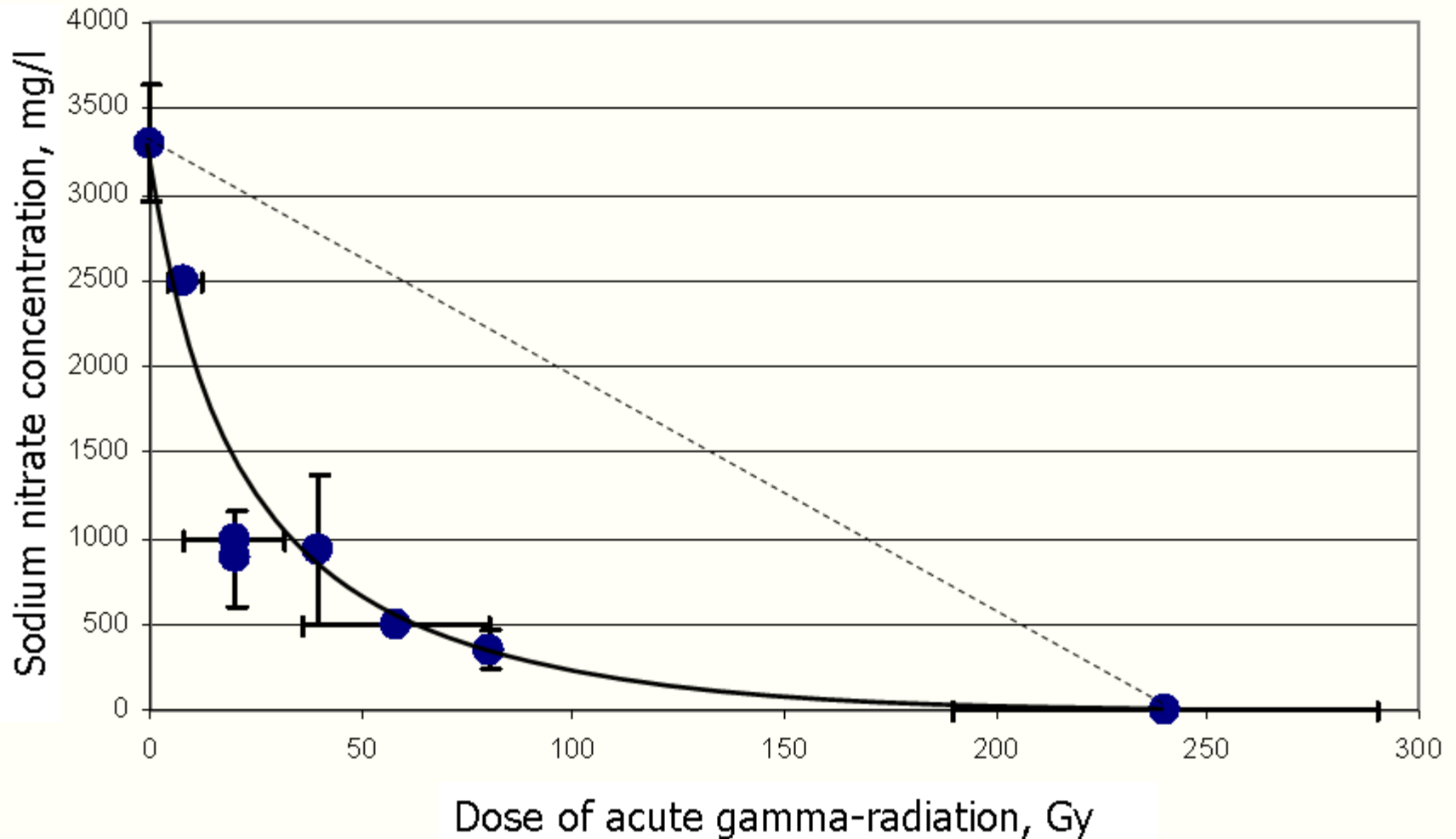


- - Mean; ● - Median
- | - 0.25 – 0.75 quantiles
- - Regression lines

Isobologram (ED_{50}) of the combined effect of the nitrates and acute gamma exposure on the growth of the algae *Scenedesmus quadricauda*



Isobologram (LD₅₀) of the combined effect of the sodium nitrate and acute gamma exposure on a 30-day survival of the oligochaetes (*T. tubifex*)



Conclusions:

1. In biocenosis with different values of radioactive contamination (the dose rate range for hydrobionts of the major ecological groups is from 0.64 mGy/day to 40 Gy/day) a typical decrease in species diversity with increase in the dose rate of ionizing radiation was revealed.
2. Chronic radiation exposure leads to changes in trophic interactions in biocenosis: in fresh water ecosystems there occurs decrease in the energy transfer from primary to secondary trophic level. With the increase in the level of radiation exposure the seasonal growth of phytoplankton biomass is accompanied with a lesser amount of growth of zooplankton biomass.
3. It is suggested that as a result of the combined effect of chronic radiation exposure and organic contamination and due to indirect effect (increase in phytoplankton biomass and the consequent hypoxia in the bottom layers of water) critical group of organisms in radioactively contaminated aquatic ecosystems is represented by bivalves of the family *Bithyniidae* and *Valvatidae*. Decrease in their number and biomass is registered at the dose rate for zoobenthos 5.6 mGy/day, and complete absence of these animals is observed when the dose rate for zoobenthos is 140 mGy/day.
4. Dependency of the hydrobionts response to radiation exposure could increase or decrease considerably (2-5 times) under combined effect of other ecological factors.