Aquatic system of Vransko jezero: Present knowledge and guidelines for management

A. Katalinić*

* Public Institution Nature Park Vransko jezero, Kralja Petra Svačića 2, 23 210 Biograd na moru, Croatia

Keywords (Arial 9pt Bold): lake; eutrophication; management

Figure 1.1 Wide-angle view on the lake, NPVJ photoarchive

The study area is Vransko jezero in Dalmatia, the biggest natural lake in Croatia, with the surface of 30,02 km², elongated in shape (13,6 km long, 1,4-3,5 km wide). Due to small depth of the lake (2-5 m), the flatter northwest part of the area allows intense growth of reed, rush and sedge, forming one of only two remaining large wetlands in the Mediterranean Croatia, the other one being the delta of river Neretva. The marsh area of 8,65 km² was pronounced an ornithological reserve and an European Important Bird Area in 1983 due to its exceptional value as a breeding, wintering and resting site for 241 birds species, and the entire lake's area is under protection in the status of a nature park since 1999. Public Institution Vransko jezero Nature Park is responsible for protection, promotion and sustainable management of the area. Because of the fragileness of wetland ecosystems in general, and relatively short-term successions that shallow lakes such as Vransko are prone to, a need has been recognized for definition of thoughtful management guidelines for this water-system, based on firm factual knowledge and clear understanding of the lake's ecological processes and interactions. Through examination of available scientific papers and inventarization studies, basic characteristics of the Vransko lake's water system have been identified and put into the context of shallow lake ecological principles.

It is known that shallow lakes, submitted to even subtle changes affecting the interrelated variables such as nutrient influx, sediment resuspension, water level, vegetation biomass, phytoplankton and zooplankton population, fish stock or herbivorous and fish-eating bird population, can easily alternate between the two opposite states: the clear, vegetation dominated state and the turbid, non-vegetated state (Scheffer, 2001). Since the 18th century the Vransko lake's area has beed submitted to significant interventions, without proper consideration of the subsequent effects on the ecosystem. First large intervention was the digging through of the Prosika canal in 1770 (800 long, 4m wide, in 1948 broadened to 8m with bottom at +0.35 m above sea level), which caused a permanent decrease in water level, presumed to have aged the lake in terms of eutrophication for several thousand years. The marsh that covered the entire Vransko field, spreading on the northwest of the lake (Figure 1.2) was dried out. Subsequent drainage of the area in the following centuries, for the purposes of agriculture, led to loss of breeding habitats for several endangered bird species: Squacco Heron *Ardeolla ralloides*, Little Egret *Egretta garzetta*, Glossy Ibis *Plegadis falcinellus* and Ferruginous Duck *Aythya nyroca (*Tutiš et all, 2003*)*. Intensive agricultural acitivities on 29km² large area have been the source of excessive nutrients into the lake.

Figure 1.2 Map of Vrana feud from 18th century, before the digging through of the Prosika canal. Borelli's archive. "Paludi di Vrana" meaning marsh of Vrana, "Lago di Vrana" meaning Lake of Vrana.

The last huge and irreversible intervention was the biomanipulation of the ecosystem by introducing cyprinid fish species that expanded in the lake, inducing its turbidity by feeding on the sediment and increasing the sediment resuspension rate. The predator species pike and catfish were introduced at the same time, allowing a new balance to be established, but nevertheless, the clear, oligotrophic state of the lake was inevitably shifted towards eutrophication.

Today the lake accepts water from a 470 km² large catchment, through rainfall and surrounding natural springs (Kakma 80 l/s, Tinjski bunar 10 l/s, Biba, 15 l/s, Begovača 5 l/s, Subiba, Veliki and Mali Stabanj, Pećina, Kneževićev izvor, Vila, Jamina and Škorobić), some of which (Kakma, Biba, Subiba, Begovača) are being exploited for the needs of water supply of Biograd and Benkovac Municipality, worsening yet the water regime of the lake (Kapelj et all, 2003). Main canals that enter the lake (Glavni and Lateralni) wash out the chemical fertilizers from the agricultural land, which induce phosphorus and nitrate levels that exceed the limiting values for waters of II cathegory, accepted for this ecosystem by the Croatian Government Plan For Water Protection (NN 7/99). pH (7,72-8,36) and oxygen values correspond to the limiting values of I cathegory, and chlorophyll a and transparency correspond to values for II cathegory waters, implying the oligotrophic to mesotrophic state of Vransko lake's watersystem (Mrakovčić et all, 2004). Macrophytes are abundant in the coastal region of the lake, contributing to water quality by trapping the sediment and providing shelter for zooplankton, which helps to keep phytoplankton population under control. They also provide food for large number of herbivorous birds, such as coots *Fulica atra*. In 2005 102 000 coots were wintering on the lake. Bird population are not be neglected, as huge densitiy of herbivorous birds can lead to severe reduction of macrophyte vegetation and subsequent increase in phytoplankton concentration, therefore turning the process towards eutrophication. Water level is highly variable, changing from recorded summer minimum of 9 cm (in 1990) to winter maximum of 230 cm (in 1974) (Švonja, 2003). Vransko Lake is a cryptodepression, with the surface level normally above sea level, and the lake bottom 3 m under sea level, covering a 29 m thick sediment layer beneath (Fritz, 1984). Therefore, seawater does not normally enter the lake, but during extermely low water levels of the lake and tidal conditions on the sea, seawater protrudes into the lake, increasing its salinity. Due to porosity of the 0,8-2,5 km wide carst barrier dividing the lake from the sea, lake water is always brackish (salinity 0,7-1,2 ‰), which inhibits the presence of the main phytoplankton grazing

Cladoceran genus Daphnia, therefore positively influencing the phytoplankton population density. This, along with nutrient influx and benthivores' sediment resuspension, explains the mild turbidity of the water, although most other factors imply the vegetation-dominated clear state of lake.

Figure 1.3 Aerial view of the Prosika canal. Abundant macrophyte vegetation near the shoreline can be noticed, confirming the vegetation-dominated clear state of the lake. NPVJ photoarchive.

Waters in protected areas present a true challenge to the institutions responsible for their management. The modern, integrative approach to nature protection implies the development of action plans in order to achieve an optimum in ecological equilibrium of the concerned system, rather than being satisfied with passive surveillance. An especially complex issue is presented by nature parks, which by definition are not intact parts of nature, but anthropogenically influenced natural or semi-natural habitats, extremely susceptible to the interaction of natural, economical and social factors. In this light, upon examination of the relevant anthropogenic influence that have affected the Vransko complex through history, guidelines for management are suggested in the paper.

Management guidelines comprehend:

- the enlargement of the Nature Park borders to the northwestern part of the Vransko field, from which intensive agriculture would be put out sequentially; State Institute for Nature Protection has already suggested an area of 1,63 km² in the Vransko field, that would be included in the Nature Park, ensuring a larger flooded plain habitat as the breeding site of several endangered bird species.
- regulation of the Kotarka water pump, a in order to maintain the ecologically acceptable minimum water level in the flooded habitat during the dry years and ensure nesting and feeding conditions for certain species of waterbirds;
- construction of a mechanical water-gate at the Prosika canal, in order to keep the minimum biological water level that positively influences the water quality, and to prevent excess salification;
- development of the fish population management study, to obtain guidelines for managing fish population and solving the enhancing eutrophication influence of the cyprinid species which feed on the sediment, especially the species unattractive to recreational fishers, such as the most progressive Prussian carp *Carrasius gibelio*;
- establishment of the continuous monitoring of lake's eutrophication, and conducting measures to slow down the eutrophication process if necessary;
- continuation of the waterfowl census, taking into special consideration the relation between the number of coots and density of macrophyte vegetation.

- development of an ecological agriculture programme in the catchment area, which will include education and financial stimulation for the farmers, in order to decrease nutrient influx into the lake.

The guidelines are to be integrated, in the form of action plans, in the 10-year management plan of the Public Institution Vransko jezero Nature Park. This line of management is necessary for supporting long-term balance of the fragile aquatic system of Vransko jezero.

References

Scheffer, M (2001) Ecology of shallow lakes. Kluwer Academic Publishers, Dordrecht 3300,Netherlands.

Mrakovčić, M. et all (2004) Cathegorization and inventarization of floristic and faunistic values of Vransko jezero Nature Park (Kategorizacija i inventarizacija floristićkih i faunističkih vrijednosti Parka prirode Vransko jezero). NPVJ prof. doc. archive, 117.

Fritz, F. (1984) Origin and geological age of Vransko lake near Biograd na moru (Postanak i starost Vranskog jezera kod Biograda na moru), Geological Newslettter (Geološki vjesnik) 37,231-243.

Kapelj, J., Kapelj, S. and Pavičić, A. (2003) Tribute to knowledge of hydrogeological and hydrogeochemical relations in the catchment of Vransko lake and Vransko field (Prilog poznavanju hidrogeoloških i hidrogeokemijskih odnosa u slivu Vranskog polja i jezera), in Hydrological stabilization and conservation of biodiversity of the Vransko jezero Nature Park catchment area (Hidrološka stabilizacija i očuvanje biološke raznolikosti slivnog područja Parka prirode Vransko jezero. Round table. Book of abstracts, 6-11. NPVJ prof. doc. archive, 77.

Pintur, G. and Tomić, F. (2003) Project proposal for improving protection and biodiversity conservation at a broader Vransko jezero Nature Park area (Prijedlog projekta za unapređenje zaštite i očuvanje biodiverziteta na širem području Parka prirode Vransko jezero), in Hydrological stabilization and conservation of biodiversity of the Vransko jezero Nature Park catchment area (Hidrološka stabilizacija i očuvanje biološke raznolikosti slivnog područja Parka prirode Vransko jezero). Round table. Book of abstracts, 1-5, NPVJ prof. doc. archive, 77.

Mišetić, S. and Mrakovčić, M. (2003) Approach to defining ecologically acceptable flow (EAF) downstream from water barriers (Pristup definiranju ekološki prihvatljivog protoka (EPP) tekućica nizvodno od vodozahvata, in Hydrological stabilization and conservation of biodiversity of the Vransko jezero Nature Park catchment area (Hidrološka stabilizacija i očuvanje biološke raznolikosti slivnog područja Parka prirode Vransko jezero). Round table. Book of abstracts, 20-25. NPVJ prof. doc. archive, 77.

Švonja, M. (2003) Hydrology of Vransko lake (Hidrologija Vranskog jezera), in Hydrological stabilization and conservation of biodiversity of the Vransko jezero Nature Park catchment area (Hidrološka stabilizacija i očuvanje biološke raznolikosti slivnog područja Parka prirode Vransko jezero). Round table. Book of abstracts, 12-15. NPVJ prof. doc. archive, 77.

Kerovec, M. and Ternjej, I. (2003) Causes of Vransko lake eutrophication and possibilities for slowing it down (Uzroci eutrofikacije Vranskog jezera i mogućnosti njenog usporavanja, in Hydrological stabilization and conservation of biodiversity of the Vransko jezero Nature Park catchment area (Hidrološka stabilizacija i očuvanje biološke raznolikosti slivnog područja Parka prirode Vransko jezero). Round table. Book of abstracts, 26-29. NPVJ prof. doc. archive, 77.

Mrakovčić, M., Kerovec, M. and Mišetić, S. (2003) Biodiversity and problems of Vransko lake biocenosis conservation (Biološka raznolikost i problemi očuvanja bicenoza Vranskog jezera), in Hydrological stabilization and conservation of biodiversity of the Vransko jezero Nature Park catchment area (Hidrološka stabilizacija i očuvanje biološke raznolikosti slivnog područja Parka prirode Vransko jezero). Round table. Book of abstracts, 34-37. NPVJ prof. doc. archive, 77.

Tutiš, V. and Radović, D. (2003) Ornithological value of Vransko jezero Nature Park and the influence of proposed hydrological stabilization on it (Ornitološka vrijednost Parka prirode Vransko jezero i utjecaj predložene hidrološke stabilizacije na nju), in Hydrological stabilization and conservation of biodiversity of the Vransko jezero Nature Park catchment area (Hidrološka stabilizacija i očuvanje biološke raznolikosti slivnog područja Parka prirode Vransko jezero). Round table. Book of abstracts, 38-40. NPVJ prof. doc. archive, 77.

Radović, D., Tutiš, V. and Kralj, J. (2004) Inventarization and valorization of Vransko jezero Nature Park's ornithofauna (Inventarizacija i valorizacija ornitofaune Parka prirode Vransko jezero). NPVJ prof. doc. archive, 108.

Radović, J., Topić, R. and Čivić, K. (2005) Scientific basis to the Vransko jezero Nature Park's physical plan with proposal of nature protection measures (Stručna podloga prostornom planu Parka prirode Vransko jezero s prijedlogom uvjeta i mjera zaštite prirode), State Institute for Nature Protection, Zagreb, Croatia, 141.