JUSTIFICATION OF A RAPID METHOD FOR DETERMINING THE SPECIES RICHNESS OF SMALL HYDRO-OBJECTS

Yu.V. Dubrovsky, Research Associate
Institute for Evolutionary Ecology NAS Ukraine, Ukraine

A simplified method is proposed for rapid assessment of the taxonomic richness of small hydro-objects by using indicator groups of aquatic organisms. It does not require any sophisticated equipment and high qualification. Therefore it is available to employees of various scientific and practicing institutions.

Keywords: species richness, small hydro-object, rapid method, aquatic, nature conservation assessment.

Introduction. Modern hydrobiological characteristics of objects, even in the most concise form, in addition to the classes of water purity and zones of saprobity, including the trophic status and bioproduction indicators, should also include the assessment of their nature conservation value. This, at first glance, can be carried out by recording the presence of ecologically significant, rare and protected species within the aquatic communities.

Presence of officially rare and protected species is, of course, an important criterion for evaluating hydro-objects. However, registration of such species, and most other aquatic species, is associated with methodological difficulties and gives incomplete information on the environmental significance of the water body. Identification of microscopic forms whose livelihoods underpin the functioning of aquatic ecosystems, require special tools and in-depth specialization. Therefore, the protection of most aquatic organisms is only possible by preserving certain types of water bodies.

An overall conservation typology of hydro-objects is virtually absent. Therefore, recording of environmental values of the objects according to their type, as well as the search for and identification of places where rare, protected and ecologically valuable species are now distributed, can be accomplished only by well-trained specialists. In addition, each of them will be guided by own experience, as the unified methodology is yet to be developed.

The relevance and state of the problem. The nature conservation value of water bodies must be taken into account when organizing local water supplies, fisheries and recreation facilities, controlling the larvae of mosquitoes, transforming the regime and changes resulting from the building-up of bank areas, as well as during works aimed at designing of areas for nature conservation purposes. Now the methodology for evaluating the importance and making comprehensive assessment of the state of protected water areas, specially adapted for conditions of Ukraine, is under development [6]. But this approach requires a qualified labor-intensive set of analyses and measurements.

The lack of reliable information on the conservation value of water bodies often leads to inadequate decisions. For example, the Environmental Prosecutor's Office in Kyiv ordered the builders, road workers to restore a partially filled-in shallow swamp, where, according to birdwatchers, gray heron would occasionally forage. However, a qualified examination showed that this site was not actually a swamp of conservation value. It was inhabited by only a few common species of aquatic insects, including larvae of mosquitoes and some green frogs of the hybrid form, which could leave the swamp when it was dry. At the same time, in the green area of the city, nobody stopped the littering of a small pond with a very diverse population, which is, moreover, the only known habitat of a unique species of nematodes in Europe. In such cases, often there is a need of rapid assessment of the ecological and nature conservation features of particular hydro-objects. At the same time, the species (or taxonomic) richness of the composition of aquatic organisms can be one of the most effective criteria.

Task statement and justification of the method. Naturally, it is impossible to take into account all inhabitants of even a small in size ecosystem [5]. The most important tasks in this case are searching for rapid indicators of taxonomic richness and development of an appropriate scale. Common rapid methods of hydrobiology for determining the trophic status and degree of water pollution (indices of Carlson and Woodiwiss) do not require deep special training and sophisticated equipment, so they have been successfully used not only by scientists, but also by practitioners [1, 7].

In particular, the Woodiwiss method is based on representation of samples of test groups of bottom-dwelling invertebrates and invertebrates found amongst the aqueous plant growth, including: flatworms, oligochaetes, leeches, mollusks, mites, higher crustaceans, larvae of dragonflies, mayflies, stoneflies, caddisflies, blackflies, mosquitoes, chironomid and crane flies, and also bugs and beetles [7]. It is known that the taxonomic (including species) richness of aquatic organisms varies depending on the degree of organic pollution of the water. In general terms it increases from contaminated areas to the clean ones [3]. Therefore, on the basis of this approach it is, in general, possible to develop a system able to assess the richness and diversity of the populations of hydro-objects. Therefore, sets of the same groups of phytophilous invertebrates (see above) incorporated by the
Woodiwiss approach can be very useful and revealing in terms of determining the species’ richness. Besides, the species (or groups), reflecting the diversity and the conservation value of water bodies should be clearly distinguishable visually and be fairly widespread. However, the assumption that indicator species and taxonomic groups are linked with the total richness of the hydro-objects may require for our purposes a considerable extension of their composition.

Species and groups with multiple biocenotic relations, can also serve as indicators of the richness and diversity of the local population. In particular, presence of euryphagous predators shows considerable richness and diversity of representatives of the previous trophic level. Example of this approach is the evaluation of richness and abundance of insects related to occurrence of insectivorous birds [2]. Small euryphages, trophically associated with the most abundant and functionally important groups of aquatic organisms, are of good indication value in this respect. In fresh water these are, first and foremost, predatory Cladocera of the genera Polyphemus, Bythotrephes and Leptodora and aquatic spider species, which, are, in addition, easily distinguished from other aquatic organisms. Observations show that they mainly inhabit waters with rich and varied composition of invertebrate prey. They should be viewed as a separate and distinct indicator group. This also applies to dragonflies. Representatives of all classes of vertebrates (excluding pets) should also be considered as indicators.

The question of using the higher aquatic plants (macrophytes) as indicators is to some extent debatable. On the one hand, their presence certainly increases the taxonomic (and environmental) richness of hydro-objects. On the other hand, significant overgrowth usually leads to waterlogging and, consequently, to a decrease in their taxonomic richness. Apparently, the inclusion of aquatic macrophytes as one separate set of indicators may be considered appropriate.

Features and examples of application of the method.

Thus, to determine the taxonomic richness of small hydro-objects it would be reasonable to use the following composition [set, list] of indicator groups: 1-higher aquatic plants (Embryobionta), 2-turbellarians (Turbellaria), 3-oligochaetes (Oligochaeta), 4-leeches (Hirudinea), 5-mollusks (Mollusca), 6-water mites (Acari), 7-7-aquatic spider (Argyroneta aquatica), 8-predatory cladocerns (genera Bythotrephes, Leptodora and Polyphemus), 9-other crustaceans (Crustacea), 10-mayflies (Ephemeroptera), 11-stonellies (Plecoptera), 12-dragonflies (Odonata), 13-megalopterans, 14-bugs (Hemiptera), 15-beetles (Coleoptera), 16-caddisflies (Trichoptera), 17-Diptera (Diptera), 18-fish (Osteichthyes), 19-amphibians (Amphibia), 20-reptiles (Reptilia), 21-birds (Aves), 22-mammals (Mammalia).

If (similar to the definition of saprobity [7]) in samples of aquatic organisms obtained from the bottom and the plant growth, and also seen visually, representatives of these groups of organisms have been encountered, then for each group one point is added. The overall rating of the taxonomic richness of the hydro-object is the sum of accumulated points. It can vary from 0 to 22 (the maximum number of points awarded when representatives of all these groups are in place).

Examples of estimating indicators:

Example No. 1 – in a floodplain lakes of a large river representatives of the following test groups have been recorded: 1, 2, 3, 4, 5, 7, 8, 9, 10, 14, 15, 16, 17, 18, 19, 20, 21. The total score in points is 17. This indicates a high taxonomic richness of the water body.

Example No. 2 – in a meadow marsh representatives of the groups have been found: 1, 3, 4, 5, 6, 9, 10, 14, 15, 16, 17, 19. The total score is 12. This corresponds to an average taxonomic richness.

Example No. 3 – in the forest puddle representatives of only the following indicator groups have been registered: 9, 14, 15, 17. The total score is 4, indicating a very low taxonomic richness.

Conclusion. The proposed method allows a very quick (sometimes - less than one hour) assessment of the taxonomic richness of the studied hydro-object. The method of assessment is fairly simple, and does not require sophisticated equipment and high qualification. Therefore, it is available to employees from practicing institutions. Despite the certain simplistic and schematic character of this approach, it gives, however, an objective (albeit approximate) idea of the general taxonomic richness of the hydro-object. Practice of hydrobiological research shows that the indicators of richness of aquatic organisms of different size groups are quite closely related.

The proposed method is designed primarily for small hydro-objects. According to the standards accepted in freshwater fish-farming, those should be regarded as the water bodies covering less than 1,000 hectares [4]. The assessment of richness of the composition of larger water areas should be preceded by consideration of their differentiation into homogeneous areas in terms of the biotope.

Of course, the taxonomic richness cannot be regarded as the sole criterion of the conservation value of a hydro-object. It is only one of such indicators. However, its advantage is the quantitative characteristic of the population of a hydro-object allowing to make the comparative analysis. The ability to handle digital information describing the objects is very much appreciated by employees of environmental administrations.

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