A PRACTICAL ASSESSMENT OF THE LIMITATIONS OF THE PREDICTIVE SYSTEM FOR MULTIMETRICS (PSYM) APPROACH TO POND CLASSIFICATION

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SUMMARY

The PSYM method is based on assumptions that are questioned. A practical example shows that these may make the method uninformative and that using Biological Methods Working Party (BMWP) scores has great limitations in connection with practical management, relating badly to the science of population dynamics. More straightforward and established indices are better and may be easier to use.

INTRODUCTION

The River Invertebrate Prediction and Classification System (RIVPACS) (Wright *et al.* 2000) and the subsequent Predictive System for Multimetrics (PSYM) (Howard 2002) are used to classify water bodies as a number on a 10-point scale as an expression of the degradation from an ideal best (10). The former is applied to rivers, the latter has been adapted for ponds and lakes. Unfortunately, the BMWP score is based on lake populations so some taxa present in ponds are not included. The ethos for RIVPACS is to set site-specific targets for the expected macro-invertebrate fauna in the absence of environmental stress, similarly PSYM is used to determine the percentage of species found which are predicted by a reference condition for a site. It can be applied using only the plants or a combination of animal families, Odonata, Megaloptera and Coleoptera, all of which have terrestrial phases in their life cycle. No mention is made of ecological succession – a vital determinant of the composition of the suites of species present as well as the assessment of management.

The PSYM (Howard 2002) sampling recording sheet allows description of the water body as well as biotic content, but with a totally inadequate space for the pond sketch (which needs to be set up as a scaled grid for easier use and greater accuracy) and without reference to photography. The recording sheet includes many subjective assessments, the pond area and percentage overhang to produce shade, for example. Such assessments are prone to error with different workers and render recognition of trends (and management success) difficult.

However, at a local level the importance of field surveys is in the identification of trends with time, involving identification at species level – as such a national classification is less important especially as nuances of change and comparison may be better expressed in terms of a Biodiversity Index (BD). The advantage of such an index is that it can be used at any time; the recommendation for the use of PSYM is for summer months, June–August only. This paper therefore, emphasises the limitation in the PSYM approach at a local county level and describes the advantages of a BD index.

The PSYM approach is based upon these assumptions:

that surveys are only carried out during the summer months;
that field workers have limited identification skills;
that it is easier to get quantifiable results if the data are recorded in a simplified form;
that a simpler (but adequate) classification of ponds can be made if the detail is simplified;
that an assessment can be made using plants only;
that an assessment can be made using Odonata, Megaloptera and Coleoptera only;
and that the necessary accompanying software is available.

This paper discusses the validity of these assumptions and hence of the PSYM methodology.

POND SURVEYS

The obvious parts of the process involved in any attempt to classify a pond are:

making sure that the water body is defined to include all parameters required by the type of survey undertaken;
that the sampling technique is well described and repeatable, bearing in mind the extreme localisation of some taxa (especially Mollusca) and that all taxa encountered are not obligate aquatics;
that all the mesohabitats are sampled;
that the number of samples permits useful analysis;
that taxa are correctly identified;
that as little disturbance of the habitat occurs as possible;
that the method takes cognisance of conservation and amelioration of the impact of repetitive sampling.

To put the PSYM in context, we describe here our current routine, both in general and by example. The field method used as standard involves more time spent in the field than just collecting and bagging up, but that time includes the major part of the identification.

General method

EQUIPMENT

A comprehensive list of equipment includes a long-handled net, hand-held GPS, folding table and stools, wide and shallow tray, several buckets, good quality hand lens (x10), light-weight forceps, small paintbrushes, tea-strainers, tea spoons, numerous numbered specimen tubes, small plastic bags for plant material, soda water[2], measuring tape and camera. Also included is 70% industrial methylated spirit (IMS). A prepared field sheet, tailored to the aims of the survey, is essential.

PROCESSES

A minimum of one hour is allowed for sampling and on-site identification at each site. The aims of the study determine the precise details of how samples are taken. In general, the best technique for gaining an overall picture of the species present is to take dips at fairly regular intervals by pacing around the pond and combining the material collected into a single sample. The total standard sampling time is three minutes. All the mesohabitats are sampled.

Adequate notes are also made in the field on the shape and size of the water body, its total surface area, the number of dips taken, the nature of the substrate, the presence of surface and/or emergent water plants and any other unusual or interesting plants or animals observed outside the terms of the survey (e.g. fish or amphibians, Water Vole signs or Otter spraints). Photographs are useful, especially for recording seasonal and annual changes. A surface plan is drawn of the pond together with a profile to show depth and width and slopes of the bank. Adjacent land use, recent management, cleaning or poaching, is noted.

The sample is sorted, live animals extracted, identified and recorded and all the material returned to the site of collection with as minimum disturbance as possible. A pre-designed field recording sheet enables a rapid check of the completed boxes.

ORGANISMS NOT IDENTIFIABLE ON SITE

Unidentified organisms may be transferred to a labelled pot with some damp vegetation and a little water for examination and subsequent identification live in the laboratory. A container with some of the source water should also be collected for use during identification. In the case of carnivorous beetles and bugs it is best to use separate pots, or otherwise have a pot containing industrial methylated spirit (IMS) if killing is necessary. Living material is returned to the site.

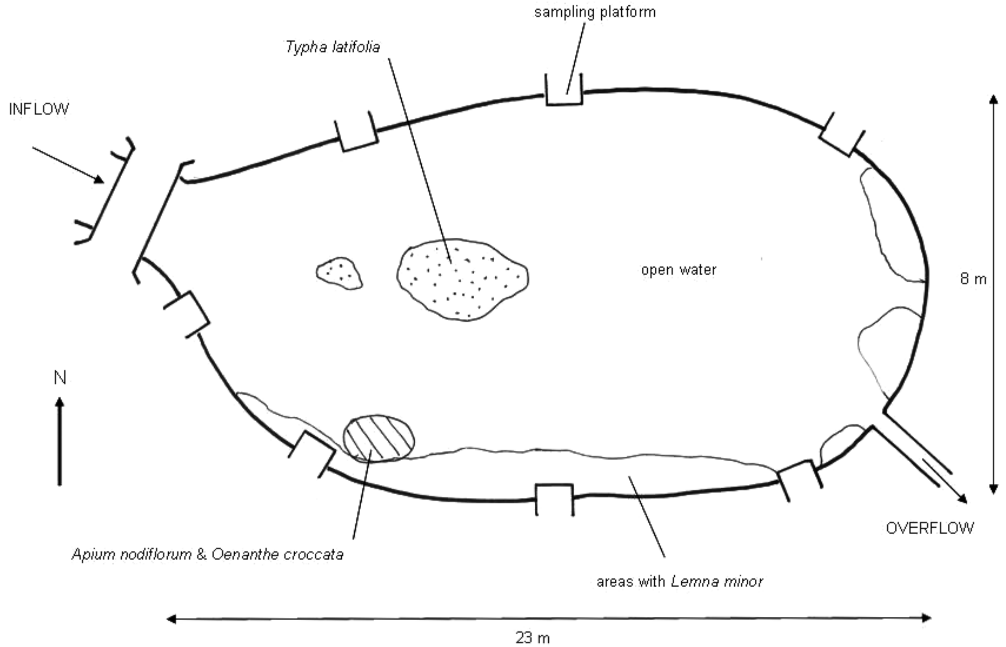

Fig. 1 Fyne Court study pond

IDENTIFICATION: PROBLEM GROUPS

Coleoptera: some species require dissection for genitalia.
Odonata: some species such as the Coenagriideae, cannot be conclusively identified in the larval stage (especially early instars of, for example, *Coenagrion puella* and *C. pulchellum* – the former is common, the latter is rare and should not be killed); however, the live animals can be kept and allowed to metamorphose; the adult being easier to identify. This argument applies to Culicidae also.

CASE STUDY: AQUATIC FAUNA OF THE POND AT FYNE COURT NATURE RESERVE

An assesssment was made of the pond used for teaching purposes at Fyne Court, Broomfield, Somerset, under the control of Somerset Wildlife Trust (Fig. 1). Sampling was carried out on 16 February 2007. We later discovered that the pond had received maintenance cleaning on 4 February 2007; no sampling was carried out prior to the cleaning so no conclusions could be reached regarding the effects of the management. Data for 16 February (species found and the numbers of individuals counted, together with their family and BMWP scores) are shown in Table 1.

A Simpson species biodiversity index (D = N(N-1)/n(n-1) where N is the total number of individuals recorded and n is the number of individuals in each species) was calculated for these data and found to be 7.72, low for a pond in a wildlife reserve in a Site of Special Scientific Interest (SSSI). Several species previously seen (in the experience of the authors) were absent and numbers were considerably lower than expected, presumably due to the cleaning. A total of 28 species (with a total of 559 individuals) were recorded in 24 families. Although details of macrophytes were not recorded, the areas occupied by the main species are shown on the sketch plan. Figure 2 gives the numerical data of the fauna expressed as total numbers of individuals in each species and graphed in order of abundance. This can readily be converted to percentage values and subsequently used as baseline data to monitor trends (or effects of management!).

PSYM analysis of these data

A partial PSYM assessment was also carried out and the group and BMWP number assigned to each

TABLE 1: SPECIES RECORDED IN THE FYNE COURT POND, 16 FEBRUARY 2007

Higher taxon	*Family*	*Species*	*No.*	*BMWP score*
Mollusca	Physidae	*Physa fontinalis*	58	3
	Hydrobiidae	*Potamopyrgus antipodarum*	3	3
	Lymnaeidae	*Radix balthica*	2	3
	Sphaeriidae	*Pisidium milium*	8	3
Hirudinea	Erpobdellidae	*Erpobdella octoculata*	2	3
	Lumbriculidae	*Lumbriculus variegatus*	3	1
Tricladida	Planariidae	*Polycelis nigra*	32	5
		Polycelis felina	23	5
Crustacea	Cyclopoida	*Cyclops* sp indet.	2	
	Gammariidae	*Gammarus pulex*	157	6
		Crangonyx pseudogracilis	11	3
	Asellidae	*Asellus aquaticus*	72	3
Arachnida	Hydracarina	Hydracarid mite indet.	1	
Ephemeroptera	Baetidae	*Cloeon dipterum*	15	4
Trichoptera	Limnephilidae	*Limnephilus lunatus*	49	7
	Sericostomatidae	*Sericostoma personatum*	3	10
Plecoptera	Nemouridae	*Nemoura erratica*	10	7
Hemiptera	Nepidae	*Nepa cinerea*	1	5
	Naucoridae	*Ilyocoris cimicoides*	1	5
Megaloptera	Sialidae	*Sialis lutraria*	2	4
Odonata	Coenagrioniidae	*Coenagrion puella*	7	6
	Libellulidae	*Orthetrum cancellatum*	1	8
Diptera	Chironomidae	*Chironomus dorsalis*	49	2
		Chironomid sp 1 indet.	8	2
		Chironomid sp 2 indet.	22	2
	Ceratopogonidae	Ceratopogonid sp indet.	4	
	Syrphidae	*Eristalis* sp indet.	10	
	Tipulidae	*Dicranota bimaculata*	1	5
Total number taxa		24 (20 with BMWP score)		
Total number individuals		558		
Diversity Index (Simpson)		7.72		
Total BMWP score		93		
ASPT score (Average Score Per Taxon)		4.65		

family recorded (Table 1). However, this was done in February which limits its validity. Figure 3 shows these data with the families in BMWP order. Since the BMWP score is based on lake data, four of the families were not assigned a BMWP score and, if this is taken into account the Average Score Per Taxon (ASPT) number was 4.65. A PSYM assessment includes information on major taxa present (flora and fauna or a selection of these) and their notional BMWP value (based on water quality) together with data incorporating the edaphic factors of the sampled site; we did not do this. All one can do with the PSYM data, apart from classifying the pond (Groups 1 with BWMP 10, to 9 with BMWP 1, another source of confusion!), is to show relative numbers within the BMWP scores, if numbers also are recorded. Trends could only be expressed in terms of the assignment code for the pond (expected) with no information about changes in types or numbers of species. A survey to determine invertebrate populations, as in our example, is predicated on identification down to species level whereas the (BMWP) system only requires a tick in a family tick-box.

DISCUSSION

The problems with PSYM

One can assume that the majority of surveys aim to:

assess the ecological importance of the site (its diversity and range of rare species);

use the initial survey as a base line for comparison

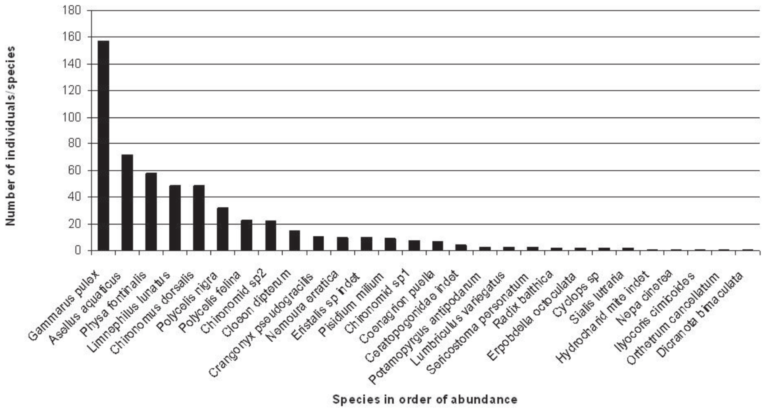

Fig. 2 Number of individuals in each species in order of abundance

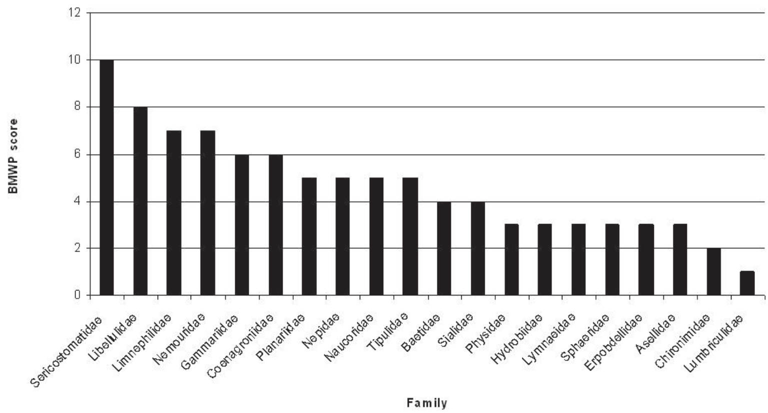

Fig. 3 Families arranged in order of BMWP scores

with other sites and for identifying trends with time.

Such aims can only be fulfilled if:

species are recorded as numerical data;
species are conserved for repeat sampling.

The PSYM scheme does neither of these. The PSYM guide states that a partial assessment can be made with plants only; however, we have found no correlation between plants on the banks and in the water and the range of animal species found (Anderson *et al*. 1994). The validity of a partial PSYM assessment is called into question further if one considers that plant succession takes place over a shorter period of time than animal succession. By including just Odonata, Megaloptera or Coleoptera, because their terrestrial phase permits dispersal, one cannot assume similar suites of species from year to year.

An assumption is made in PSYM that all species within a family have the same ecological significance ('weight') but it is well known that ecological requirements for species, even within the same genus, are not necessarily the same. (Note the pollution-tolerant *Baetis rhodani* within the pollution-intolerant Ephemeroptera: Baetidae – but which is regarded separately in the RIVPAC scheme, or the pollution-tolerant *Anisus leucostoma* within the Planorbiidae.) Identification to family level in such cases must therefore call logically into question the validity of this approach.

Using PSYM alone would not highlight the interesting data which often arise with isolated ponds within an area. For example one pond on Pawlett Hams, Bridgwater Bay, contained a population of *Daphnia magna*, another species, *Asellus meridianus* was found in five out of twelve ponds, a species once present in Somerset ditches also but which has now largely disappeared (Hill-Cottingham and Smith 1998).

The problems with BMWP

The BMWP list implies that it is so time-consuming and difficult to identify certain species that one has to rely on family-level taxa. We would protest that some families are quite difficult to identify and while one is ascertaining the family it is often but a small step away from the specific taxon. We would even dare to suggest that many taxonomists would, having identified a species, be forced to look up its family – especially where names are different and the continuing research into nomenclature keeps changing the names of families and the species contained within them! Note the paradox of the family designation of freshwater limpets (no haemoglobin): one, *Ancylus lacustris* in the Ancylidae and the other two, *Ferrissia wautieri* and *Ancylus fluviatilis* in the Planorbiidae a family of ram's-horns, with haemoglobin and low-oxygen-tolerant (Anderson 2005)!

We think that people who do the field work should not only have the ability to identify BMWP families in the field but also be competent to name the majority of species. We think that the BMWP list catastrophically simplifies the invertebrate recording with the result that the basic data used in characterising a body of water, with the essential element of species identity thrown out, is unreliable. We acknowledge that some species are impossible to identify in the field and such species (depending on the aims of the survey) need laboratory investigation, but we would argue very strongly that on-site identification of samples is essential for the conservation of the invertebrate population and that it should be the norm. In most cases, killing of whole samples is undesirable since observation of behaviour of live organisms is often a major determinant in identification. Killing and removal is more a matter of convenience for the recorder and takes no cognisance of conservation values. Many species are rendered unidentifiable by immersion in formalin or spirit; for example Tricladida and Hirudinea – both taxa include obligate aquatics and; therefore, are extremely useful in monitoring trends and changes in water quality.

We are aware that the BMWP dataset from a site, as stated in the PSYM guide 'provides a standard assessment method for still waters which enables a variety of organisations involved in water body management to consider water quality in a broad national context' and as such it fits into mathematical models but we would argue that the derived statistics such as abundances and diversity indices, requiring numerical data, are valuable and more informative in characterising real examples of water body at the local level, particularly in combination with a knowledge of successional stage.

It seems apparent that collection of numerical species data has a far greater value than numbers of major taxa containing often disparate species with different ecological requirements and impacts. For example, Trichoptera is a good example of a taxon containing species with highly diverse habitat requirements – in both lentic and lotic waters. Furthermore, by not recording species, there is little opportunity to highlight rare species. Many rare species survive in 'poor' water with low oxygen concentrations, including several mollusc and beetle species such as the very rare *Segmentina nitida* RDB1 (present in one ditch in Somerset), and *Hydaticus transversalis* RDB3 (one of eight freshwater beetle species found on every Moor in Somerset). The danger is that such rare species may suffer loss of pond habitats classified as 'poor quality' and therefore assumed to be of little biological interest.

Species lists, recording actual numbers of individuals, enable establishment of base-line data to determine trends over time and more accurate comparisons to be made between different bodies of water. Abundance data enables a study of species composition and population structure, functional groupings in relation to trophic levels and food webs, whilst still incorporating all that is available with the PSYM.

All one can do with the PSYM data, expressed in families, is to show relative numbers of families within the BMWP scores (Fig. 3). Trends can only be expressed in terms of the assignment code for the pond (based on expected data) with no information about changes in types of species or numbers of individuals.

Using numerical abundance data one can compare sites in space and time and, in particular, on numbers of species and the number of individuals within each species to obtain an index of diversity. Furthermore, such diversity indices give a far better assessment of the importance of a site than a general classification such as BMWP groupings where the level of discrimination between sites/samples would be minimal.

CONCLUSIONS

The following points summarise the inadequacies of PSYM and the PSYM Guide:

The PSYM scheme seems to depend on circular arguments – predicted species dependent on recorded species deciding the predicted species!

Family recording ignores the unique species information resulting from geographical isolation.

How is the importance of rare species highlighted?

Simplification of data conceals nuances of differences important in defining the habitat as well as assessing trends with time.

No explanation of the meaning of 'overall quality' of a pond – it is not clear whether the BMWP scores are based on tolerance of low oxygen concentration or pollution (or a mixture of both?).

There can be great variation in ecological requirements between species within a family.

It is easier to trace synonymy for species than for families.

There should be emphasis on field identification and conservation.

The importance of the behaviour/movement of the living organisms in identification is ignored.

The predicted scores ignore local suites of species and food webs around the country, isolation, and the relevance of succession.

Aquatic larvae (and other obligate aquatics, such as Mollusca, Hirudinea and Tricladida) vulnerable to aquatic pollution, are more important in characterising the pond than the adult dispersal phase.

The one essential, submerged indicator plant for faunal biodiversity is *Lemna trisulca*. Why is it included amongst the floating plants since it cannot compete with floating duckweeds because it hangs below the surface?

Methods that rely on convergence, i.e. circular processes of estimating a state, only work if the number of cycles is set by a rule that is dependent in some way on the properties of the data set. Some sets will need more cycles than others to reach a point in which there can be confidence. We do not see that such a process is present in this method. One cycle, surely, is hardly going to be enough.

Classification is based on set characteristics whereas habitats change through time according to a) succession (biotic factors), b) other environmental factors (edaphic and climatic) e.g. climate change, flooding etc, or c) man's intervention e.g. management, disturbance, pollution. Prediction in terms of the PSYM process takes no cognisance of these considerations which will affect all sites in terms of their flora and fauna but to differing extents. Practical naturalists look at sites in terms of the above changes. In our opinion we do not see how population dynamics can fit into the fixed groups within the PSYM assessment. Population dynamics can determine the success or loss of a species independently of the environment.

To be convincingly practical, we feel that it needs to be made possible to insert data for obviously significant species and successional stages as well as families. Does PSYM suit the needs of conservationists? Surely not. A diversity index together with details of species present, which can be used as a tool for monitoring change over time and assessing management of the habitat, is more meaningful. We do question whether there is a real need for classifying ponds, nationally, in a way that gives so little information for the practical ecologist. Classifying ponds is only practically useful if the target is reasonable and the assessment method provides a means of comparison with it. We cannot see that this has been achieved. The published and advised methodology does not demonstrate this. Can it be reasonable to accept the implicit argument 'This is the only method we've got so use it' if both the assumptions and the likelihood of getting a sound comparison with the ideal target have not been demonstrated? We need demonstrations of this before proceeding to use the method. We certainly would worry if PSYM analyses were to replace detailed numerical surveys within the wildlife and conservation organisations in Somerset. Or should the crunch question be: 'Who teaches the taxonomists'?

Endnotes

[1] The authors, Dr Pat Hill-Cottingham BSc, PhD, PGCE, FPSCE, CBiol, MIBiol, and Anthony Godwin Smith BA, BEd, FPSCE, CBiol, MIBiol are semi-retired independent environmental consultants, working mainly on macro-invertebrates and macrophytes in freshwater habitats in Somerset.

[2] Trichoptera: Until recently we would have taken all caddis into IMS and examined them in the laboratory but now we use a new AIDGAP key, *Simple Key to Caddis Larvae* (Wallace 2006).The 'key' to examining caddis larvae is their immobilisation and that used to involve killing in 70% alcohol. But now

they can be arrested using soda water in a teaspoon on site and the new key treats both cased and caseless caddis in one slim volume of less than 60 pages. Not everything keys down to species but most do and the few that prove intractable on site will be readily solved under the microscope. Soda water (which does not harm the organisms) can also be used in the field for examining damsel flies and dragonflies and mayflies, in conjunction with the FBA keys.

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