Chapter 14
Observer Variation in River Macrophyte Surveys

The Results of Multiple-Observer Sampling Trials on the Western Cleddau

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Introduction

In 2008 we carried out multiple-observer sampling trials on two stretches of the Western Cleddau, a lowland river in south-west Wales. These trials were set up to determine the rates of observer variation between surveyors, specifically in relation to the detection of macrophyte species and estimates of vegetation cover. These are key components of all forms of river macrophyte survey and monitoring projects in UK rivers.

The Sampling Trial Locations

The sampling trials took place in two sections of the Western Cleddau, the first extending for 500 m downstream of St Catherine's Bridge (Site 5 in Fig. 17.1), and the second extending for 100 m upstream from the small road bridge in Wolf's Castle (Site 3 in Fig. 17.1). These sites are separated by a distance of more than 8 km.

The 500 m Section at St Catherine's Bridge

This section comprises shallow riffles (<1 m deep) and deeper pools (up to 1.5 m deep). The river is about 13 m wide in this section (Fig. 14.1), and it was possible, with careful navigation, to complete the recording without leaving the river. Despite this, most surveyors got out of the river on at least one occasion to avoid having to negotiate the deeper sections of channel.

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Fig. 14.1 Part of the 500 m sampling trial section at St Catherine's Bridge. *Photo by Clive Hurford*

Fig. 14.2 Part of the 100 m sampling trial section at Wolf's Castle. *Photo by Clive Hurford*

The 100 m Section at Wolf's Castle

The river is about 8 m wide in this section and is shallow riffle habitat <1 m deep throughout its length (Fig. 14.2). All surveyors recorded the full 100 m section without leaving the river.

Methods

The data were collected on seven dates from 23rd June to 30th September 2008, within the recommended period for macrophyte recording in the UK. On four dates, two surveyors were in the river at the same time, though working independently. On the other three dates, a lone surveyor was accompanied by a non-participating colleague for health and safety purposes.

Eleven experienced professional botanists participated in the sampling trial. These included three accredited freshwater specialist surveyors, six 'non-specialist' surveyors who had previously received Mean Trophic Rank (MTR) training, and two surveyors who had never received training in freshwater macrophyte sampling methods. All participants were familiar with the aquatic flora of the region.

For the data collection exercise, we asked the surveyors to record cover estimates for all higher and lower plants (mosses and liverworts), lichens and algae present in the river channel. To minimise the scope for observer interpretation of the term 'river channel', we asked the surveyors to record 'all macrophytes submerged or partly submerged in the river within the survey length'. We modified an existing macrophyte recording form to meet the purposes of the survey. The surveyors were also asked to record how long was spent surveying each stretch of river.

As the exercise focused primarily on species detection, as opposed to species identification, the surveyors could take samples away with them and submit their recording forms after difficult specimens had been verified (by an appropriate referee if necessary). Similarly, there was no time limit on the exercise; we asked the surveyors to stay on site until they were satisfied that the sample was complete.

We excluded the bank flora from the sampling trials, as the levels of observer variation associated with recording terrestrial vegetation are already well documented (Leach and Doarks 1991; Hurford 2006).

Finally, we asked the surveyors to collect data only under optimal conditions during the recommended sampling period for river macrophyte surveys i.e. during periods of low flow and good water clarity in the period from June to September.

Issues Associated with Collating the Data

As the sampling trials focused on recording the diversity and cover of aquatic and emergent species, we removed all other species from the dataset following advice provided by Nigel Holmes and Richard Lansdown. We then collated all of the surveyors' data into a master dataset.

If there was any doubt over the presence of a species in the river sections, we removed that species from the master dataset that we used to determine species detection rates. We did not, however, remove any aquatic or emergent species from the individual surveyors' datasets, as these are the data that they would have presented under normal circumstances.

Finally, as we believe that all of the Batrachian *Ranunculus* vegetation in the river was hybridised, we lumped all *Ranunculus* records into a single indeterminate

group. The *Ranunculus* was variably recorded by the surveyors as *R. fluitans*, two subtypes of *R. penicillatus*, *Ranunculus* hybrid and as indeterminate *Ranunculus*.

Results

The sections below outline the results of the sampling trials, focusing on the species detection rates and cover estimates in the 500 m and 100 m sections of river.

Detection Rates for Aquatic and Emergent Plants in the 500 m Section

At least 59 aquatic and emergent species were present in the 500 m section, comprising 12 species of algae and lichen, 14 species of bryophyte and horsetail, and 33 species of vascular plant. Table 14.1 highlights those species (excluding algae) with high detection rates (>75%), and those with low detection rates (<20%).

Detection Rates for Aquatic and Emergent Plants in the 100 m Section

At least 48 species of aquatic and emergent plant were present in the 100 m stretch of river. These comprised 13 species of algae and lichen, 14 species of bryophyte and 21 species of vascular plant. Table 14.1 highlights those species with high and low detection rates. Figure 14.3 shows the distribution of detection rates for species in this section.

Cover Estimates

The range of observer variation associated with the estimates of vegetation cover in each section is outlined below.

Cover Estimates for Aquatic Species in the 500 m Section

Only two species were recorded as achieving more than 1% cover in this section, these were the various forms of *Ranunculus* recorded (grouped here as *Ranunculus* sp.) and *Verrucaria* sp. The range of observer variation associated with the cover

Table 14.1 Vascular plant and bryophyte species with detection rates >80% (*left*) and <20% in the 500 m and 100 m river sections. Note that *Juncus effusus* and *Iris pseudacorus* appear on both sides of the table, reflecting their relative abundance in the two sections

Species with a high detection rate of >80%	Detection rate (%)		Species with a low detection rate of <20%	Detection rate (%)	
	500 m	100 m		500 m	100 m
Agrostis stolonifera	82		*Alnus glutinosa*	9	
Apium nodiflorum	91	91	*Conocephalum conicum*	9	9
Callitriche brutia		91	*Epilobium parviflorum*	9	
Chiloscyphus polyanthos	91	100	*Equisetum palustre*	18	
Fontinalis antipyretica	100	100	*Fissidens curnovii*		18
Fontinalis squamosa	100	100	*Fontinalis antipyretica* var. *gracilis*		9
Glyceria fluitans	100	91	*Glyceria notata*	18	9
Iris pseudacorus	91		*Glyceria x pedicellata*	9	
Juncus effusus	82		*Amblystegium* sp.		18
Myriophyllum alterniflorum	91	91	*Hygrohypnum* sp.	18	9
Oenanthe crocata		91	*Iris pseudacorus*		18
Persicaria hydropiper	100		*Juncus acutiflorus*	9	
Phalaris arundinacea	100	100	*Juncus effusus*		9
Ranunculus sp.	100	100	*Lejeunea lamacerina*	9	
Sparganium emersum		82	*Lemna minor*		9
Sparganium erectum	100		*Lunularia cruciata*		9
			Mentha aquatica	18	
			Myosotis sp.	18	18
			Pellia epiphylla	9	9
			Porella pinnata	9	18
			Salix cinerea	9	9
			Salix viminalis		9
			Scirpus sylvaticus	9	
			Stachys palustris		18
			Veronica beccabunga		9

estimates for these species is shown in Table 14.2. No seasonal pattern was evident in the dataset: if there was a significant reduction of *Ranunculus* cover throughout the recording period, it was hidden within the range of observer variation present in the dataset.

Cover Estimates for Aquatic Species in the 100 m Section

Six species were recorded as achieving more than 1% cover in the 100 m section at Wolf's Castle: these were *Vaucheria* sp., *Chiloscyphus polyanthos*, *Fontinalis antipyretica*, *Fontinalis squamosa*, *Myriophyllum alterniflorum* and *Ranunculus* sp.

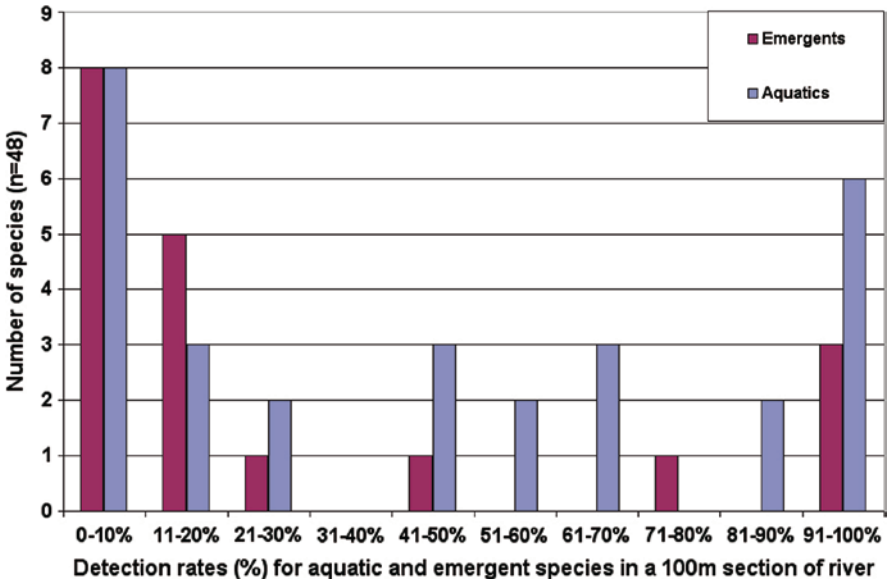

Fig. 14.3 The detection rates for aquatic and emergent species in the 100 m section at Wolf's Castle. Half of the species have a less than 20% chance of being detected

Table 14.2 The range of observer variation associated with the cover estimates recorded for aquatic species in the 500 m section of river at St Catherine's Bridge

	Minimum cover		Maximum cover		Range of variation	
Species	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)
Ranunculus sp.	4	260	40	2,600	36	2,340
Verrucaria sp.	<1	<65	60	3,900	59	3,835

Of these, the major cover-formers were the two species of *Fontinalis*, *M. alterniflorum* and *Ranunculus* sp. The range of observer variation associated with the cover estimates for these species is shown in Table 14.3.

Estimating the cover of the two species of *Fontinalis* presented a difficult challenge for the surveyors, who not only had to attempt to separate the species from the other bryophytes in the channel, but also had to try and separate them from each other.

The cover estimates for *Ranunculus* sp. ranged from 0.1–1% (<8 m^2) to 30% (240 m^2), with specialist surveyors recording both of these estimates on the same day (2nd July). All of the subsequent estimates fell within this range. There was no obvious seasonal pattern to the cover estimates, with 30% cover being recorded on 2nd July and 25% cover recorded on 30th September (see Fig. 14.4).

Table 14.3 The range of observer variation associated with the cover estimates recorded by the surveyors for aquatic species in the 100 m section at Wolf's Castle

Species	Minimum cover		Maximum cover		Range of variation	
	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)
Ranunculus sp.	0.1–1	8	30	240	29	232
Myriophyllum alterniflorum	0.1–1	<8	25	200	24	192
Fontinalis antipyretica	<1	<8	12	96	11	88
Fontinalis squamosa	<1	<8	10	80	9	72
Fontinalis sp.	<1	<8	15	120	14	112
Chiloscyphus	<1	<8	3	24	2	16
Vaucheria sp.	<1	<8	5	40	4	32

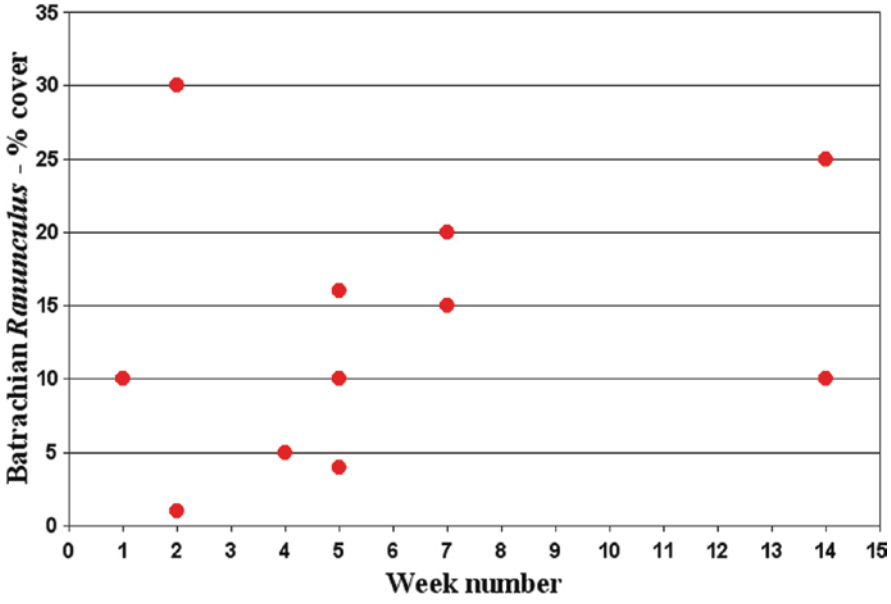

Fig. 14.4 The cover estimates recorded by the surveyors for Batrachian *Ranunculus* species in the 100 m section of river at Wolf's Castle. Note that the range of cover estimates recorded by accredited surveyors on the same day in Week 2 encompassed all of the cover values recorded by the other surveyors in the 14-week period from 23 June to 30 September

Variation in the Time Spent Collecting Data

The time that the surveyors spent recording the 500 m section ranged from 1 h 20 min to 3 h, while the time spent recording the 100 m section ranged from 35 min to 1 h 15 min. This equates to a minimum of 36 m^2 per minute for the 500 m section and a minimum of 11 m^2 per minute for the 100 m section. For comparison, an experienced terrestrial surveyor might spend 90 min recording a 2 × 2 m quadrat in grassland.

Discussion

The Western Cleddau sampling trials were carried out to assess the levels of observer variation associated with recording river macrophytes. All of the data used for assessing observer variation were collected under optimum conditions in the period recommended for collecting macrophyte data in the UK.

Although the data were collected on various dates in the period from 24th June to 30th September 2008, on four occasions data were collected by two different surveyors on the same day: these datasets allowed us to isolate examples of true observer variation from seasonal change.

Surveyor Performance in Recording Species Diversity

The results from the Western Cleddau sampling trials show a similar pattern to the results from similar exercises carried out in terrestrial habitats. For example, Leach and Doarks (1991) found that no surveyor recorded more than 73% of the species in a fixed 1 × 1 m quadrat in grassland vegetation, and that no surveyor recorded more than 63% of the species in a 10 × 10 m quadrat. By comparison, no surveyor recorded more than 64% of the aquatic and emergent species in the 500 m section on the Western Cleddau, and no surveyor recorded more than 54% of the species in the 100 m section.

With the exception of the freshwater algae and lichens, where the specialist surveyors consistently recorded more species than the non-specialists, there was no obvious difference between the specialist and non-specialist surveyors (Table 14.4).

However, despite their increased awareness of freshwater algae, there was little agreement between the specialist surveyors as to which species of algae were present: only four of the 11 species were recorded by more than one specialist surveyor.

Surveyor Performance in Recording Cover Estimates

With regards to observer variation in cover estimates, the results from the Western Cleddau trials again showed a similar pattern to the results from sampling trials in terrestrial habitats. Sampling trials in blanket bog vegetation (Hurford 2006) found that estimates of ericoid cover varied by a mean of 36% between observers. By comparison, estimates of vegetation cover for the main cover-forming species in the Western Cleddau varied by a mean of 24% between observers, with no difference between the non-specialist and specialist surveyors (Table 14.5).

Table 14.4 The mean numbers of species recorded in each section by the non-specialist surveyors and the accredited specialist surveyors

Species group	Mean number of species recorded in the 500 m section	
	Non-specialist surveyors	Accredited specialists
Aquatic algae and lichens	3	5
Aquatic bryophytes	5	5
Aquatic vascular plants	8	7
Emergents	12	15
Total	28/59 (47%)	32/59 (54%)
Species group	Mean number of species recorded in the 100 m section	
	Non-specialist surveyors	Accredited specialists
Aquatic algae and lichens	4	7
Aquatic bryophytes	5	6
Aquatic vascular plants	6	5
Emergents	7	4
Total	22/48 (46%)	22/48 (46%)

Table 14.5 The range of cover estimates recorded by the non-specialist and specialist surveyors for the major cover-forming species in the 100 m and 500 m sections of river

Species	Range of cover estimates recorded in the 500 m section	
	Non-specialist surveyors	Accredited specialists
Batrachian *Ranunculus*	4–40%	7–25%
Species	Range of cover estimates recorded in the 100 m section	
	Non-specialist surveyors	Accredited specialists
Batrachian *Ranunculus*	4–25%	1–30%
Myriophyllum alterniflorum	4–20%	1–25%

Conclusions

The sections on surveyor performance illustrate that there was no appreciable difference between the accredited specialist and non-specialist surveyors, either in terms of their ability to record species diversity or estimate vegetation cover. The fact that no surveyor recorded more than 54% of the aquatic and emergent species in a shallow 100 m section of river suggests that macrophyte data collected from both 100 m and 500 m sections of river are likely to be seriously compromised by observer variation.

Half of the species in the 100 m section had a low detection rate (<20%), including *Iris pseudacorus*, *Juncus effusus*, *Lemna minor*, *Stachys palustris* and *Veronica beccabunga*: these species do not present identification difficulties. Neither does *Potamogeton perfoliatus* (Fig. 14.5), which was overlooked by almost half of the surveyors (including two of the three specialists) in the 500 m section of river.

Fig. 14.5 Only 55% of the surveyors recorded this 7 × 2 m patch of *Potamogeton perfoliatus* in the 500 m section at St Catherine's Bridge, including only one of the three specialist surveyors. *Photo by Clive Hurford*

In practice, if a species was locally distributed in the survey sections it had a <20% chance of being detected. These detection rates reflect the inability of the surveyors, no matter how experienced, to critically survey the required areas of search: c. 6,500 m^2 for the 500 m section of river and c.800 m^2 for the 100 m section of river. In effect, the expertise of specialist surveyors is being nullified by the methods that they are being asked to use.

The implications of these sampling trial results for established macrophyte recording methods are discussed in Chapter 15.

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