Research Brief

Modifying Surber sampling technique increases capture of freshwater crabs in African upland streams

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Abstract

We compared 2 methods for sampling the freshwater crab *Potamonautes odhneri* (Colosi) in Kenyan streams: standard Surber sampling, in which a sample is taken over a period of several minutes; and rapid Surber sampling, in which the process is reduced to around 10 seconds. Rapid Surber sampling caught more crabs than standard Surber sampling, This suggests that the crab species investigated is normally able to evade capture if sampling is carried out at an unhurried pace, but that if precision is sacrificed for speed, then capture efficiency increases. The size of crabs caught using the 2 techniques was similar, and use of baited traps set in the same locations showed that Surber sampling methods were not capturing larger individuals. Like all methods available to sample large benthic crustaceans, rapid Surber sampling has its limitations, but this study demonstrates that it can be used as a method for rapid assessment of crab presence and for comparative determination of population density, to significantly greater effect than the standard method of Surber sampling.

Key words: population estimation, *Potamonautes odhneri*, sampling method, tropical streams

Introduction

Estimating population density and biomass of large crustaceans is complicated by the difficulty of taking quantitative samples. Different methods are often selective, being variously more effective at catching adults or juveniles, or even being biased in favour of different sexes (Rabeni et al. 1997, Costa and Negreiros-Fransozo 2002, Taggart et al. 2004, Gladman et al. 2010). Baited traps in particular are biased toward large individuals (Turnbull-Kemp 1960, Disney 1971, Hill and O'Keeffe 1992, Somers and Nel 1998, Smith et al. 2004, Dobson et al. 2007a). Furthermore, use of baits as attractants means that the area sampled is unknown. Among river-inhabiting freshwater crab species, use of baited traps can be improved by isolating a section of stream and then repeat sampling (Turnbull-Kemp 1960) or by employing mark-recapture techniques (Butler and du Toit 1994), thereby overcoming the problem of an unknown area being sampled. However, the method needs a large number of traps and requires multiple site visits; furthermore, if mark-recapture is employed, it is also time intensive in the field. It is, therefore, inappropriate as a technique for rapid assessment of population density. In addition, such modifications do not overcome the problem of size-selectivity, so that only a small proportion of the total population will be sampled.

Active benthic sampling techniques such as Surber or Hess sampling are widely used as a standard procedure for assessing macroinvertebrate populations in streams and shallow rivers. However, their efficiency at catching freshwater crabs is untested, although benthic surveys using these methods in South Africa (King 1983) and Kenya (Dobson et al. 2002) reported very low densities of crabs. This may be because crab density was indeed low in the sites sampled; alternatively, crabs may be able to move quickly in response to disturbance and therefore avoid capture. Both possibilities would reduce the

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Table 1. Physicochemical characteristics of the study sites. Analysis of measurable cations and anions was carried out once for each site, based on samples taken on 14 July 2004. These were filtered in the field, frozen, and transported to Manchester Metropolitan University where concentrations were determined using a Dionex ion chromatograph. Water depth, pH, and conductivity were measured on each visit to the sites.

	Burguret River	**Naro Moru River**
Location (lat; long)	0°6′33.48″S; 37°2′19.80″E	0°9′19.80″S; 37°0′43.56″E
Altitude (m a.s.l.)	1930	1950
Width at study site (m) – mean (range)	6.9 (6.1–7.8)	7.2 (7.1–7.3)
Baseflow water depth at study site (m) – mean (range)	0.22 (0.11–0.28)	0.10 (0.05–0.15)
pH	7.8–8.0	8.0–8.7
Conductivity (μS cm^{-1})	68–79	67–68
Na (mg L^{-1})	12.95	10.86
Mg (mg L^{-1})	1.11	1.33
K (mg L^{-1})	1.76	1.59
Ca (mg L^{-1})	3.64	4.87

efficiency of benthic sampling for assessing crab numbers. However, whereas the low density problem cannot be overcome without taking many more samples than is normally feasible, the crabs' ability to escape capture can be addressed by modifying the sampling procedure. Therefore, we hypothesised that a method such as Surber sampling can be adapted to be more effective at catching crabs, simply by increasing the speed and vigour of sampling.

The aim of this study was to determine the differences in crab capture rates that would result from use of different sampling methods. It compared a standard benthic sampling technique using a Surber sampler with a modification of this technique in which precision was sacrificed in favour of speed to reduce the time available for crabs to escape. In addition, baited traps were used to determine the extent to which Surber sampling captured large crabs.

Study site

The study was carried out at a single site in each of 2 adjacent rivers, the Burguret River and the Naro Moru River (Table 1), draining the western slopes of Mt. Kenya and inhabited by the potamonautid crab species *Potamonautes odhneri* (Colosi). Both rivers ran through cleared land at the study sites but were shaded by riparian trees. The Naro Moru River was bordered on one side by a shaded lawn in the grounds of the Naro Moru Lodge and the other side by thick scrub. The Burguret River site had a narrow riparian zone (<5 m deep) along both banks but was immediately downstream of woodland. Each river reach had a bed of cobbles and larger stones, although the Burguret River also had some exposed bedrock. Further details of vegetation at these sites may be found in Dobson et al. (2002).

Methods

Benthic samples were taken using a Surber sampler (area 25 × 25 cm, mesh size 250 μm). Two methods were used: "standard" and "rapid" Surber sampling. Standard Surber samples were taken after carefully placing the net at the designated sample point, washing particles of substratum in the net, and ensuring that all parts of the sample area were equally covered; each sample was taken over a period of approximately 2 min. Rapid Surber samples were taken by the observer identifying the sample point while standing at least 2 m downstream. The net was placed into position, and all loose substratum within the sample area was thrown into the net and the net lifted out of the water; the entire procedure takes no more than 10 s. The aim was not to take a timed sample, but to take a sample as spatially quantitative as possible within a time short enough to reduce the opportunity for crabs to escape.

Traps were constructed from a solid steel frame, 20 × 20 × 40 cm, with a 5 mm steel mesh. One end comprised a cone-shaped opening with inward-pointing flexible wire that animals could push apart to enter but which then spring together, making exit extremely difficult. The opposite end contained a hinged door held shut with wire (see Dobson 2004 for photograph). Traps were baited with pieces of freshly purchased, baked *Tilapia* fish suspended from the roof of the trap with wire so that they were inaccessible from the outside. Traps were placed in relatively deep (minimum 10 cm) parts of each river, downstream of boulders and therefore relatively slow-flowing.

Sampling was carried out on 2 occasions. On the first occasion, 15 traps were placed arbitrarily along a 15 m stretch of each river in the evening of 8 July 2004, left overnight, and emptied the following morning. Immediately prior to retrieval of the traps, 20 Surber

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samples were taken from each river stretch, 10 of each type; these were taken randomly within riffle areas, and the choice of standard or rapid sample was determined randomly in advance. On the second occasion, Surber sampling (10 of each type) was repeated during the afternoon of 13 July; traps were then set in the evening and emptied the following morning.

All crabs caught were preserved in the field in 70% alcohol and returned to the laboratory for analysis. Carapace width (CW) was determined using callipers to the nearest 0.1 mm for all specimens caught.

Numbers of crabs caught were not normally distributed, so comparisons between the different Surber sampling methods were made using Friedman's test, with 4 site-date blocks. Individual crab sizes (CW) were compared among the 3 sample methods using one-way ANOVA, following $\log_{10}$ (n) transformation; post hoc pairwise differences in CW were compared using Tukey's HSD test. Analyses were carried out using Systat version 11.

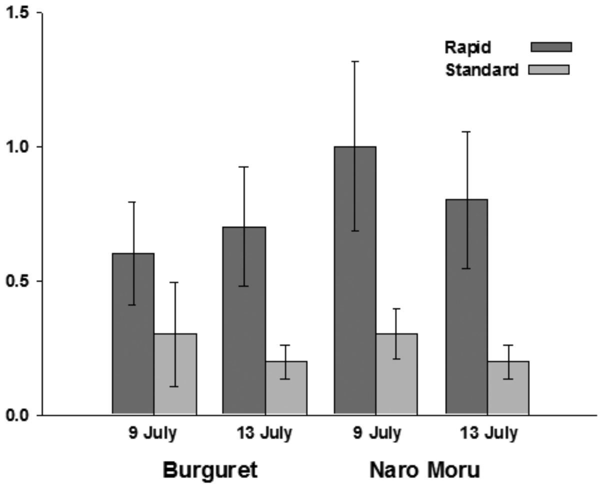

Fig. 1. Number of crabs (mean ± 1 s.e.) caught in the 2 sample sites on 2 sampling occasions using rapid Surber sampling (dark bars to the left of each couplet) and standard Surber sampling (pale bars to the right of each couplet). Values given are numbers per Surber sample.

Results

The rapid Surber sampling method caught significantly more crabs than the standard method at both sites and on both occasions ($\chi^2 1 = 3.841$, $P < 0.05$; Fig. 1); 18 of the 40 rapid samples contained crabs, with a total catch of 30 crabs. In contrast, only 9 of the 40 standard samples contained crabs, and the total catch was 9 individuals.

The size of animals caught differed significantly among the methods used ($F_{2,\ 115} = 104.93$, $P < 0.001$). Baited traps caught significantly larger animals than Surber samples (Tukey's test $P < 0.001$); however, there was no difference in sizes caught between rapid and standard Surber samples (Tukey's test: $P = 0.989$). Mean CW of trapped animals was 28.3 mm, whereas for Surber samples it was 15.0 mm, and Surber samples caught very few animals in the size range encountered in the traps (Fig. 2).

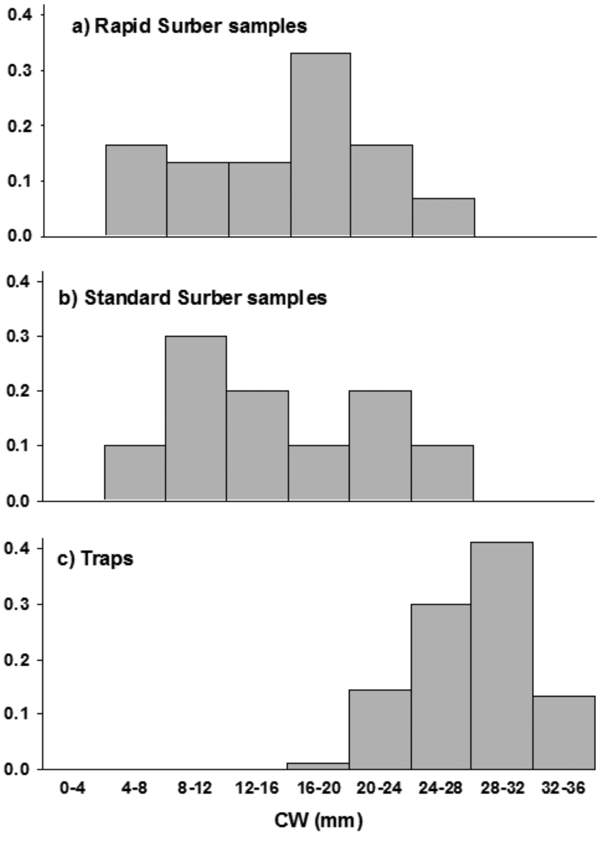

Fig. 2. Proportion of crabs caught in different size classes by different sampling methods. Size classes are based on carapace width (CW), divided into 4 mm intervals. Data from the 2 sample dates have been combined.

Discussion

This study suggests that the low number of crabs in benthic samples can be a consequence of their ability to evade capture. Changing the Surber sampling method to reduce escape time significantly increased numbers captured, a result that was consistent across both sites and sampling dates. Furthermore, the similar size of individuals caught using the 2 Surber methods demonstrates that this species' ability to evade capture is not size dependent. The ability of the rapid method to sample invertebrates other than crabs was not tested; its efficiency is likely to be reduced but may allow some comparison with samples for other fauna taken using a standard Surber sampling technique because it covers an equivalent area.

A comparison of methods for sampling crayfish (*Pacifastacus leniusculus* Dana) in Scottish rivers determined that use of a Surber sampler was the least efficient in determining presence or absence of the species (Gladman et al. 2010); this and other studies on crayfish (e.g., Rabeni et al. 1997, Price and Welch 2009) demonstrate that electrofishing using multiple passes is the best method. However, if electrofishing is not possible, this modified Surber sampling approach can be a good indicator of presence or absence of large benthic crustaceans, and probably of relative abundance. It may therefore be an effective compromise as a rapid assessment technique if crabs are the main subject of interest, giving better population estimates than other rapid techniques without the need for repeat visits and equipment left in rivers required by most of the more intensive techniques. Indeed, even mark-recapture and repeat trapping would require simultaneous quantitative benthic sampling to determine populations of smaller individuals.

The rapid Surber sampling method did, however, continue to miss the larger-sized individuals. This difference in size classes among the sample methods demonstrates the difficulties in estimating population densities and biomass for a species whose different life stages require different sampling methods. It could be argued that the Surber sampler used was too small for effective sampling and that a net-based sampler covering a larger area would be more successful at capturing a representative cross-section of the population. However, this assumption is refuted by Somers and Nel (1998), who surveyed *Potamonautes perlatus* Milne-Edwards in South Africa by placing a 1 m^2 enclosure into the stream channel and attempting to remove every crab contained within it. Even using this method, their largest-bodied sample averaged CW 19.5 mm, and no specimens larger than 44 mm CW were captured, whereas their baited traps caught crabs averaging 44 mm CW and reaching a maximum of 56 mm.

The rapid Surber method may have worked well in the study streams as a consequence of the high population densities of crabs often encountered in African rivers (Dobson et al. 2007b). However, the results obtained suggest that this method is worth considering in situations where rapid assessment is required and resources are limited. Freshwater crabs have been identified as key components of freshwater biodiversity (Darwall et al. 2005) and are among the few groups of freshwater invertebrate species listed in the Red Data Book. The rapid Surber sampling method may be an improvement on the more qualitative hand searching that is the other main contender for rapid population assessment of these species.

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