Summary of Fisheries Assistance Project

Carribean National Forest June 1996

United States Department of Agriculture Forest Service
Center for Aquatic Technology Transfer
Department of Fisheries and Wildlife Sciences
Virginia Tech, Blacksburg, VA 24061-0321

Summary of Fisheries Assistance Project

Carribean National Forest June 1996

United States Department of Agriculture Forest Service
Center for Aquatic Technology Transfer
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-032

C. Andrew Dolloff
Unit Leader

Kevin N. Leftwich
Lead Fisheries Biologist

Martin K. Underwood
Fisheries Biologist

Prepared by:

Kevin N. Leftwich and C. Andrew Dolloff

April 1997

Background

In Summer 1996 we were invited by personnel of the Caribbean National Forest (CNF) to evaluate their stream habitat and aquatic fauna inventory and monitoring plan and to train CNF personnel in basinwide visual estimation techniques (BVET). Training was performed on the Quebrada Jiménez between 25 June and 1 July. We used the data collected in the training-survey to evaluate protocols for sampling stream habitat and aquatic fauna in the CNF.

Methods

We used visual estimation techniques and a stratified random sampling design to estimate surface area of selected habitat types and abundance of fish, shrimp, and crab species in a 1400 m section of the Quebrada Jiménez (Figure 1) (Hankin and Reeves 1988; Dolloff et al 1993). **Note:** *for training purposes, we deviated from standard BVET protocols by 1) allowing multiple observers to estimate habitat and 2) using visual estimation of habitat only in the measured habitat-units.* We identified all habitat in the study section by unit type: pools (areas in the stream with low water velocity, streambed gradient near zero, and a smooth water surface), glides (areas in the stream that are morphologically similar to pools but with swift water velocity through most of the unit), runs (areas in the stream with relatively steep gradient, with rapid, non-turbulent flow), riffles (areas in the stream with relatively steep gradient, shallow water, relatively high velocity, and turbulent surface), and cascades (areas in the stream with greater than about a 12% gradient and high velocity).

The first unit of each habitat type selected for paired estimates and measurements of surface area and sampling by divers was determined randomly. Additional sampling units were selected systematically. In each habitat-unit selected for sampling we determined 1) wetted stream width (visually estimated and measured to the nearest 0.1 m), 2) habitat-unit length (measured with a hip chain to the nearest 0.1m), 3) stream channel width (visually estimated and measured to the nearest 0.1 m at bankfull as described by Harrelson et. al 1994), 4) dominant and subdominant substrata particle size (as defined by CNF protocol), 5) percentage of canopy closure (visually estimated and measured by a spherical densiometer), 6) instream cover (total linear distance to the nearest 0.5 m of undercut banks, boulders, and the percentage organic material), and 7) maximum and average depth (measured to the nearest 0.01 m - average depth of each habitat unit was estimated by taking depth measurements at various places across the channel profile with a graduated staff) .

When a habitat-unit selected for underwater observation was encountered, divers entered at the downstream end and proceeded slowly upstream to the head of the unit while searching for and counting all target species. When a target animal was sighted, it was directed out of the line of travel by the diver's hand to prevent double counting. Hipchain measurements were used to locate each sample unit on 7.5 minute USGS topographic maps.

We used three-pass removal (Zippen 1958) electrofishing (one DC backpack electrofisher) to estimate the populations of all species by habitat-unit and to obtain a calibration ratio ($\hat{Q}$) for each species in a subset of habitat-units sampled by divers (5 pools and 5 cascades). All target animals captured during the three-pass depletions were identified and weighed (g). We measured total length (mm) of fish, total length and carapace length (mm) of shrimp, and carapace width (mm) of crabs.

Results and Discussion

Habitat - We identified 72 pools, 21 glides, 3 runs, 16 riffles, and 53 cascades in the study section. The mean surface area of sampled habitat-units (14 pools, 5 glides, 3 riffles, and 11 cascades) ranged from 21 m^2 for pools to 62 m^2 for cascades (Figure 2). We estimated the average stream channel width to be 13.9 m. The width of the stream channel, however, was variable (Figure 3).

The mean percentage of canopy covering the study section was 65% (Figure 4). The amount of instream cover in the study section averaged 20 m (linear distance; Figure 5) but the percentage of organic cover averaged less than 4% of each habitat-unit. We identified cobble and large gravel as the most common (modal) dominant and subdominant substratum, respectively, in the study section. The dominant and subdominant substrata, however, varied between habitat types (Figures 6 and 7).

Maximum depth in the study section ranged from a 30 cm in riffles to 140 cm in pools (Figure 8). Likewise, average depth ranged from a 10 cm in riffles to 70 cm in pools (Figure 8).

Habitat Correction Factors - We selected a total of 10 riffles and cascades (combined) and 10 pools and glides (combined) for paired samples of habitat surface area (visually estimated and measured). Linear regressions indicated a weak relationship between the visual estimation of area and the measured area; relative to more experienced observers (Dolloff et al. 1993; Figures 9a and 9b). These results were expected because multiple observers were allowed for training purposes. Multiple observers violates the assumption - " accurate estimates of habitat areas requires that a single experienced observer be responsible for all visual estimates" (Hankin and Reeves 1988).

The linear relationship between estimated and measured channel width (n = 8) was poor ($r = 0.35$, $p = 0.40$; Figure 9c). Although the precision of the estimates was affected by the use of multiple observers, it appears some inconsistencies in identifying the stream channel also occurred between observers. Nevertheless, this problem can be easily corrected by clearly defining the stream channel (e.g. based on bankfull flows; see Harrelson et al. 1994) and practicing the estimation technique.

Finally, the linear relationship between the estimated and the measured percentage of canopy coverage (Figure 9d) indicated this procedure may be useful for this variable. Although the relationship was not strong ($r = 0.67$) or significant ($p = 0.28$), practicing the procedure may greatly improve its precision and thus become a useful tool.

<u>Species Distribution and Relative Abundance</u> - We observed nine freshwater shrimp species, two fish species, and one freshwater crab species in the study area (Table 1). Most species were distributed through out the study section (Figure 10). However, *Micratya poeyi* was observed only in riffles (n = 2) and *Macrobrachium carcinus* in pools (n = 2). Although this may suggest some degree of habitat selectivity, a larger sample size would be needed to determine any relationship between these species and habitat type.

Agnostomus monticola were observed only in one pool in the downstream 280 m of the study section (Figure 10). This species was not observed above a large, vertical cascade (located about 590 m downstream of the Highway 966 bridge) which may be a barrier to migration for this species.

Atya lanipes was the most common species captured during the electrofishing survey, comprising about 41% of the total catch (Figure 11). Conversely, *Macrobrachium faustinum* was the least abundant, comprising less than 1% of the total electrofishing catch (Figure 11).

<u>Sampling Efficiency</u> - Neither three-pass removal electrofishing estimates nor diver counts appeared to be reliable for estimating the population for most species in the study area. We observed 'depletions' (by species) using three-pass removals in only 32% of our attempts in habitat-units that contained target species (Table 2). This indicates that we violated the assumption that the probability of capture was constant between passes (Zippen 1958).

This may be the result of both the biology of the target species and the morphology of the study area. *Epilobocera sinuatifrons, Sicydium plumieri*, and nine of the shrimp species are cryptic, benthic animals which lack anatomic structures, such as swim bladders, that would allow the organism to float from the bottom once stunned by electrical current. Thus, the first electrofishing pass may dislodge many of the species from their hiding places making them more vulnerable to capture in the second or third pass.

In some cases the opposite may be true and also related to differences in species' biology or the amount and type of cover. For example, *S. plumieri* was often observed in greater numbers by divers than captured during three-pass removals in the respective habitat-unit (Figure 12). This suggest that, in some cases, the target organisms may avoid capture by seeking and remaining in heavy cover.

Some of the shrimp species, however, appeared to be rare and patchily distributed in the study area and we therefore were unable to evaluate the usefulness of this technique in all cases. However, the rare shrimp species exhibit many of the same characteristic as the more abundant shrimp species and we would expect the effectiveness of three-pass electrofishing removal to be similar for all shrimp species. Nevertheless, the usefulness of electrofishing for these species warrants further investigation.

In general, the relationship between diver counts and electrofishing was poor (Figure 12). In most cases, divers grossly underestimated the number of target organism captured during the electrofishing survey. This may partly be attributed to the cryptic nature of most of the species and the inability of the divers to detect these organisms in heavy cover. Nevertheless, 9 of the 12 target species were observed in $\leq$ 5 of the 10 paired sample-units and therefore the relationships between diver counts and estimates for these species were unclear (Figure 12). The remaining species, *M. heterochirus*, *X. elongata*, and *S. plumieri*, were present in at least seven of the paired sample-units.

Macrobrachium heterochirus was observed in all 10 of the paired samples and the relationship between diver counts and electrofishing estimates was correlated (r = 0.62, p < 0.001; Figure 12). The divers consistently underestimated the number of *M.*

heterochirus which can normally be "corrected" using the BVET. In this case, however, the regression line through the data does not intercept the *y*-axis near the origin which indicates a large amount of variability between the diver counts and electrofishing estimates (Figure 12). As a result, a calibration ration develop from these data would be questionable.

Sicydium plumieri was also observed in all 10 of the paired samples; however, the relationship between diver counts and electrofishing estimates was poorly correlated ($r = 0.25$, $p = 0.48$; Figure 12). Further, we observed a negative relationship between the diver counts and the electrofishing estimates (Figure 12). This relationship was the result of divers often seeing more *S. plumieri* than were captured electrofishing.

Our data indicated that corrected diver counts may be useful for *Xiphocarus elongata*. The linear relationship between diver counts and electrofishing estimates (due to poor depletion estimates we based our estimate on the total number captured) was significant and highly correlated ($r = 0.93$, $p < 0.001$; Figure 13). Unlike most of the other shrimp species examined in the study section, *X. elongata* was primarily observed in the water column, and more easily seen by divers.

Agonostomus monticola was observed in only one paired sample; however, the diver count ($n = 2$) matched the electrofishing removal estimate. *Agonostomus monticola* is also a water column (fish) species and appears to be easily observed by divers (personal observation). Although the relationship between diver counts and removal estimated needs further investigation, we assume, based on species exhibiting similar behavior (USFS Southern Research Station published and unpublished data), this technique should be suitable for this species.

Length-Weight Relationships - We used linear regression to examine the relationships between all target species lengths and weights to be used as a reference for future studies. The length-weight relationships are given in Appendix A.

Conclusions and Recommendations

Correlations between visual and measured estimates of habitat in the Quebrada Jiménez were generally weak and therefore valid correction ratios could not be calculated. Nevertheless, the streams of the Caribbean National Forest appear to be morphologically similar streams in the southern Appalachian Mountains of the eastern United States (personal observation) where the BVET has been has been demonstrated successful for inventorying stream habitat (Dolloff et al. 1994; Dolloff et al. in press). The difference between the precision observed in the Quebrada Jiménez and precision observed in other studies may be related to the use of multiple, 'inexperienced' observers in the process of being trained. We believe that results similar to those in the southern Appalachians can be achieved in the CNF once field crews gain experience and consistency.

Neither underwater observation nor three-pass electrofishing appear to be suitable for estimating the populations of most of the species in the Quebrada Jiménez. Based on our admittedly limited data, calibration ratios to correct for observer biases can not be computed.

Selection of alternative sampling designs should be based on the objectives of the study. For example, both underwater observation and three-pass electrofishing may be useful measures of relative abundance, whereas other sampling techniques may be better suited for estimating the populations. Although time-consuming, mark-recapture techniques may be more appropriate for population estimation because estimates are based on the proportion of individuals marked and recaptured.

Regardless of the sampling technique used, we suggest that the BVET protocol be followed for selection of sample sites. Random (or random-systematic) selection of naturally occurring habitat-units (e.g. pools and riffles) as sample sites greatly improves statistical validity of stream habitat inventories.

Literature Cited

Dolloff, C. A., D. G. Hankin, and G. H. Reeves. 1993. Basinwide estimation of habitat and fish populations in streams. General Technical Report SE-83. Asheville, North Carolina: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experimental Station. 25 pp.

Dolloff, C.A., H.E. Jennings, and M.D. Owen. (in press). A Comparison of basinwide and representative reach habitat survey techniques in three southern Appalachian streams. North American Journal of Fisheries Management.

Hankin, D. G. and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences. 45: 834-844.

Harrelson, Cheryl C.; Rawlins, C. L.; Potyondy, John P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

Zippen, C. 1958. The removal method of population estimation. Journal of Wildlife Management. 22:82-90.

Table 1. Aquatic species present in survey of Quebrada Jimenez.

Scientific Name	Code	Common Names
Atya innocous	ATIN	guabara, chagara
Atya lanipes	ATLA	guabara, chagara
Atya scabra	ATSC	gata
Macrobrachium carcinus	MACA	camaron del rio
Macrobrachium crenulatum	MACR	coyuntero
Macrobrachium faustinum	MAFA	coyuntero
Macrobrachium heterochirus	MAHE	silgao
Micratya poeyi	MIPO	camaroncito de rio
Xiphocarus elongata	XIEL	chirpi, salpiche
Epilobocera sinuatifrons	EPSI	buruquena, crab
Sicydium plumieri	SIPL	olivo, chupa, goby
Agonostomus monticola	AGMO	dajao, mtn. mullet

Table 2. Three-pass removals of species in the Quebrada Jimenez. Valid depletions are identified by YES, invalid are identified by NO, and asterisks represent not applicable. Species abbreviations are given in Table 1.

Unit Type	Pass	AGMO	ATIN	ATLA	ATSC	EPSI	MACA	MACR	MAFA	MAHE	MIPO	SIPL	XIEL
Cascade	1	0	0	1	0	0	0	0	0	4	0	4	1
	2	0	0	0	0	1	0	0	0	8	2	0	0
	3	0	0	0	1	0	0	0	0	1	1	0	0
Depletion		*	*	YES	NO	NO	*	*	*	NO	NO	YES	YES
Pool	1	1	0	0	0	0	0	0	0	1	0	0	14
	2	1	0	0	0	0	0	0	0	4	0	0	6
	3	0	0	0	0	1	0	0	1	3	0	1	15
Depletion		YES	*	*	*	NO	*	*	NO	NO	*	NO	NO
Cascade	1	0	0	0	0	0	0	0	0	3	0	4	0
	2	0	0	0	0	1	0	0	0	3	1	2	0
	3	0	0	0	0	0	0	0	0	2	0	1	0
Depletion		*	*	*	*	NO	*	*	*	YES	NO	YES	*
Pool	1	0	0	0	0	0	0	1	0	6	0	2	11
	2	0	0	0	0	0	0	0	0	2	0	0	5
	3	0	0	0	0	0	0	0	0	0	0	1	0
Depletion		*	*	*	*	*	*	YES	*	YES	NO	NO	YES
Pool	1	0	0	1	0	0	0	0	0	7	0	0	0
	2	0	0	0	0	0	0	1	0	1	0	0	0
	3	0	0	1	0	0	0	0	0	1	0	0	0
Depletion		*	*	NO	*	*	*	NO	*	YES	*	*	*
Cascade	1	0	0	2	0	0	0	0	0	3	0	2	0
	2	0	0	0	0	0	0	0	0	1	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
Depletion		*	*	YES	*	*	*	*	*	YES	*	YES	*

Table 2. Continued

Unit Type	Pass	AGMO	ATIN	ATLA	ATSC	EPSI	MACA	MACR	MAFA	MAHE	MIPO	SIPL	XIEL
Pool	1	0	0	2	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	1	1
	3	0	0	0	0	0	0	0	0	0	0	0	0
Depletion		*	*	**YES**	*	*	*	*	*	*	*	NO	NO
Cascade	1	0	0	3	3	0	0	0	0	0	0	2	0
	2	0	2	0	0	1	0	1	0	3	0	0	0
	3	0	0	2	1	0	0	0	0	1	0	2	0
Depletion		*	NO	NO	NO	NO	*	NO	*	NO	*	NO	*
Cascade	1	1	1	30	0	8	0	0	0	1	0	2	2
	2	0	0	24	1	4	0	0	0	2	0	0	4
	3	0	0	55	1	10	0	0	0	3	0	2	6
Depletion		**YES**	**YES**	NO	NO	NO	*	*	*	NO	*	NO	NO
Pool	1	0	0	4	0	0	0	0	0	0	0	0	2
	2	0	0	11	0	1	0	1	0	0	0	0	5
	3	0	0	9	0	0	0	0	0	0	0	0	2
Depletion		*	*	NO	*	NO	*	NO	*	*	*	*	NO

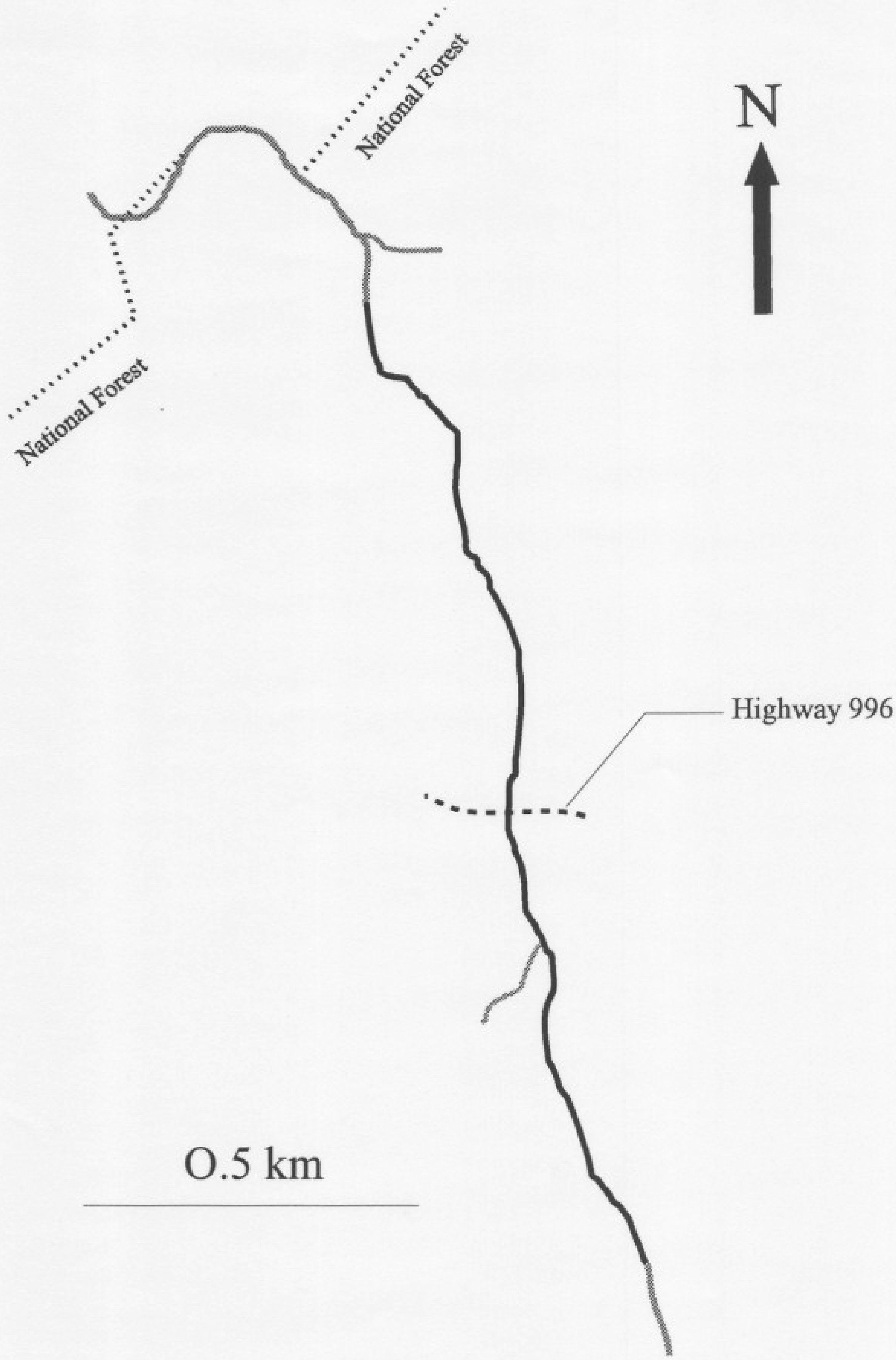


Figure 1. Quebrata Jimenez on the Carribean National Forest. Black line defines study section and gray lines indicates areas not sampled.

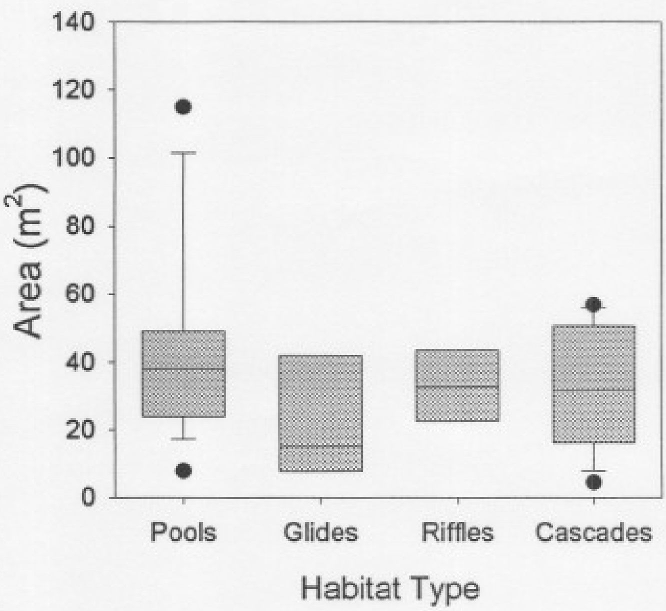


Figure 2. Box plots for habitat-unit surface area. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers, and the solid line in the box represents the median.

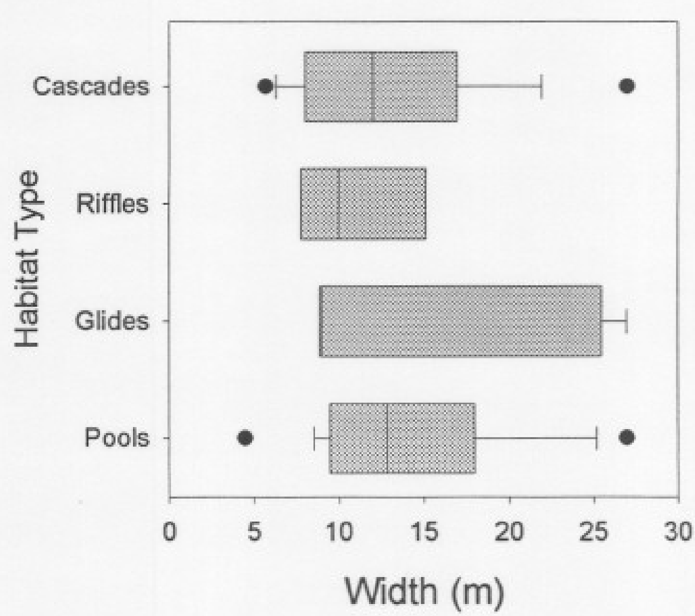


Figure 3. Box plots for stream channel width. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers, and the solid line in the box represents the median.

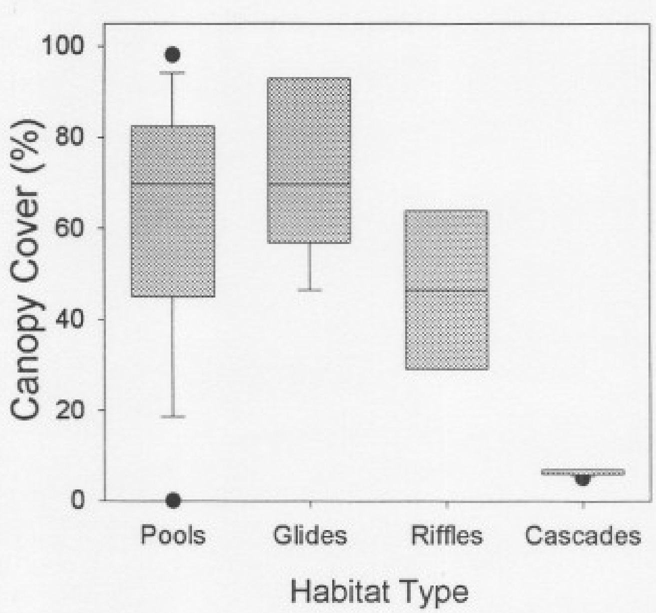


Figure 4. Box plots for the percentage of canopy covering each habitat-unit. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers, and the solid line in the box represents the median.

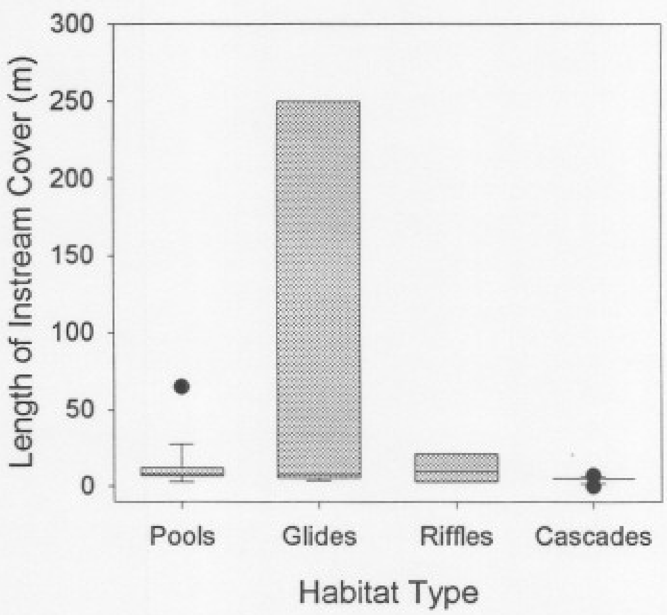


Figure 5. Box plots for the linear distance of instream cover in sampled habitat-units. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers, and the solid line in the box represents the median.

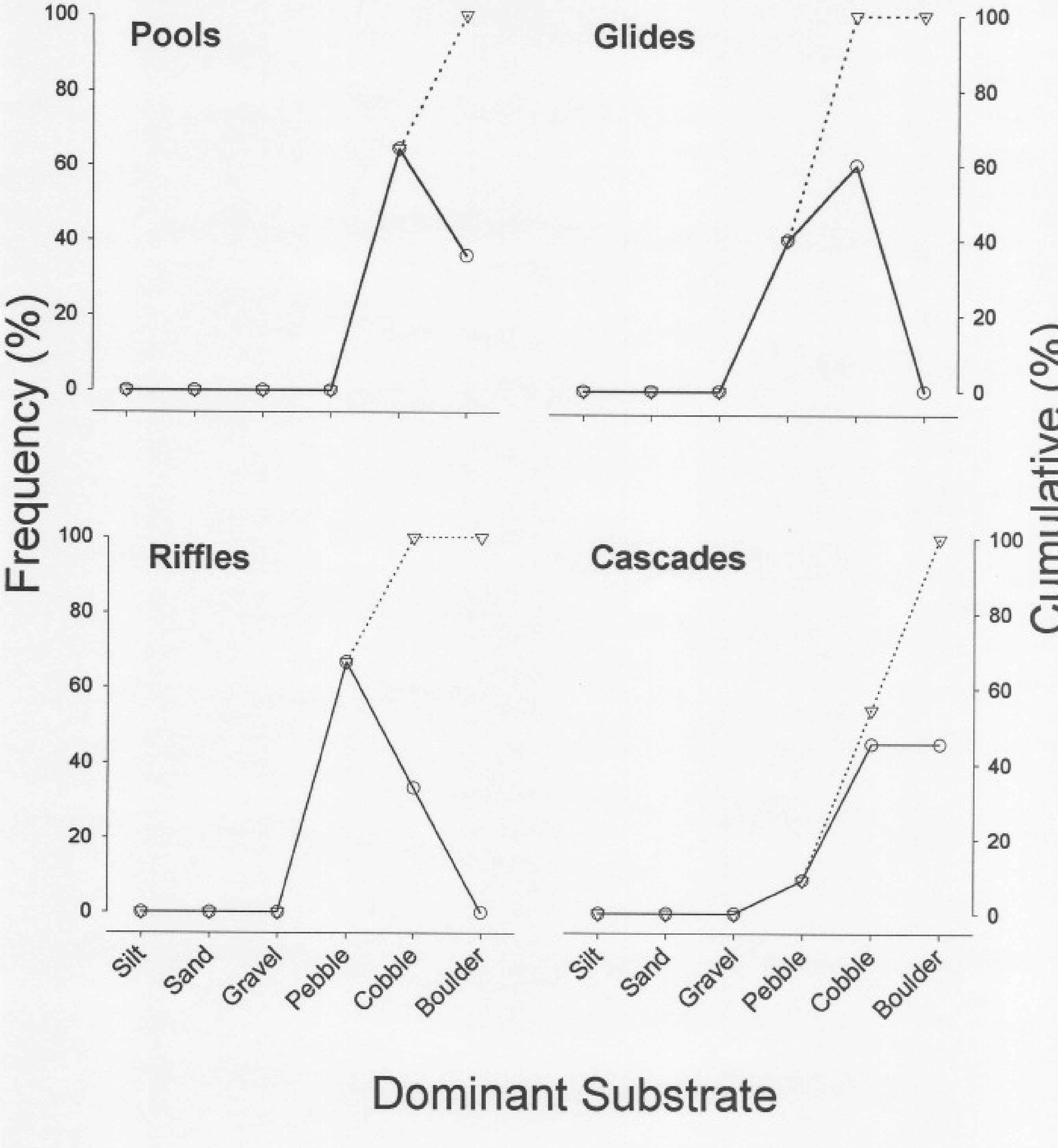


Figure 6. Frequency (percent) of dominant substrate occurrence by sampled habitat type. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative percent.

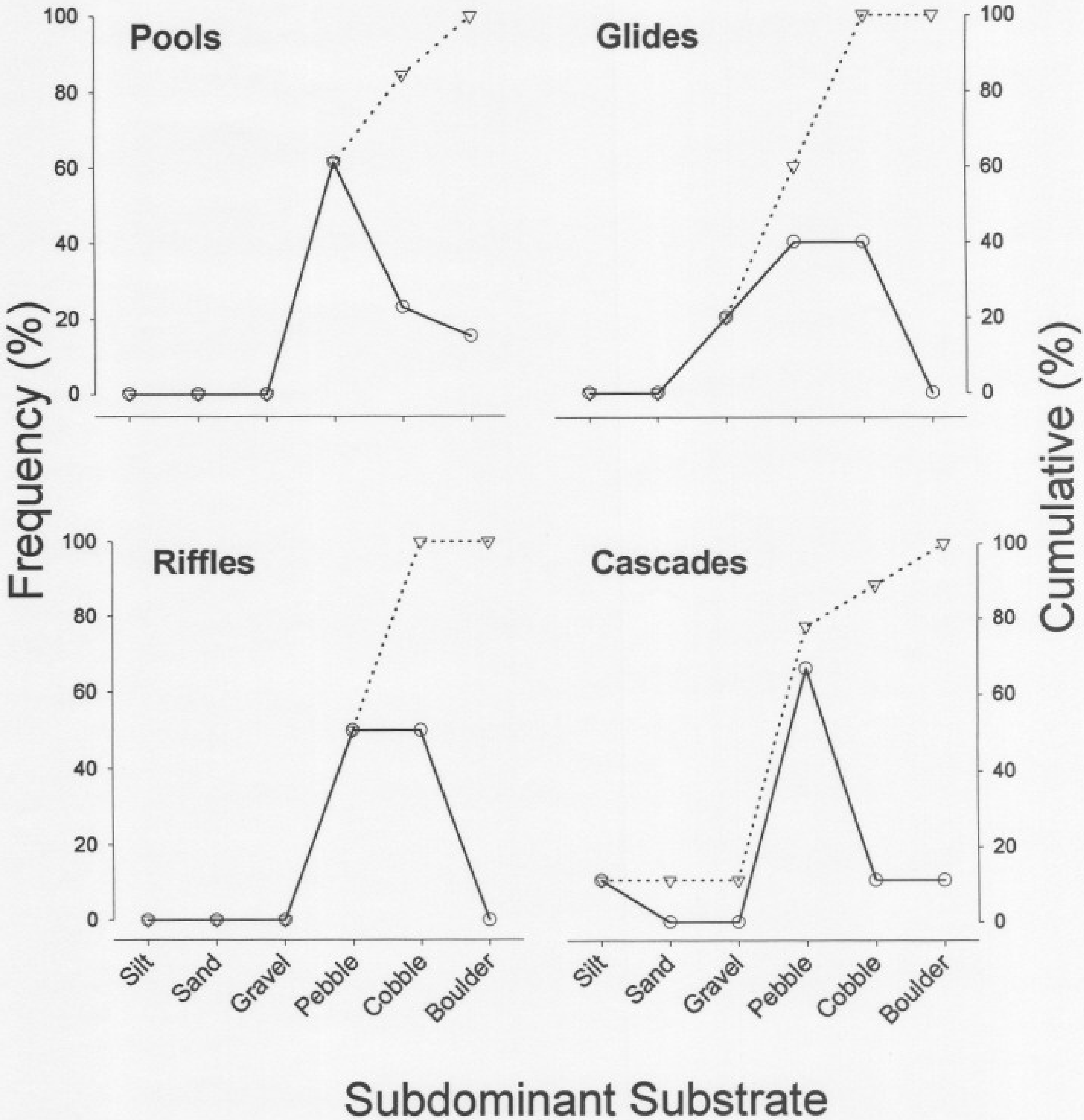


Figure 7. Frequency (percent) of subdominant substrate occurrence by sampled habitat type. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative percent.

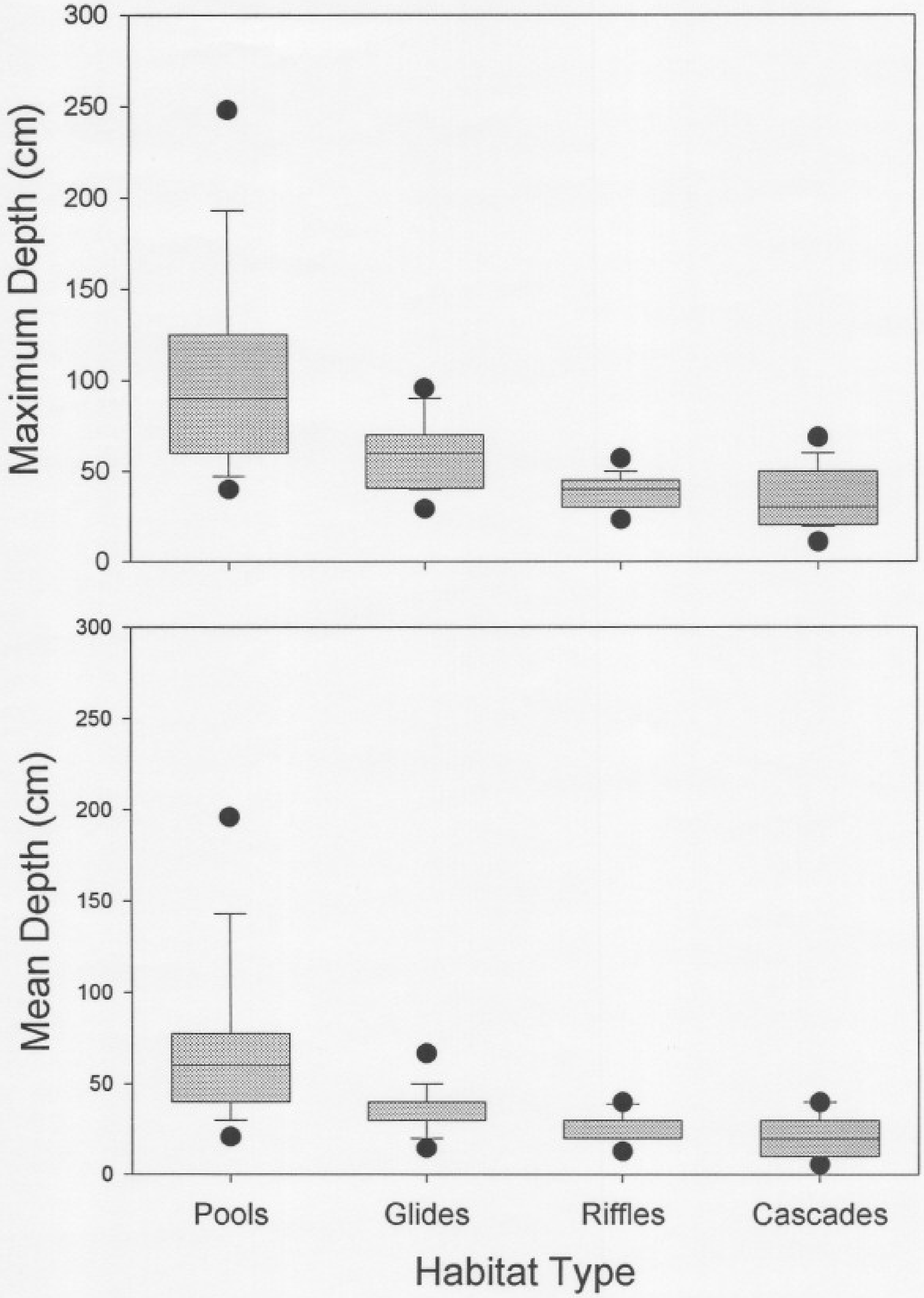


Figure 8. Box plots for maximum and mean depth. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers, and the solid line in the box represents the median.

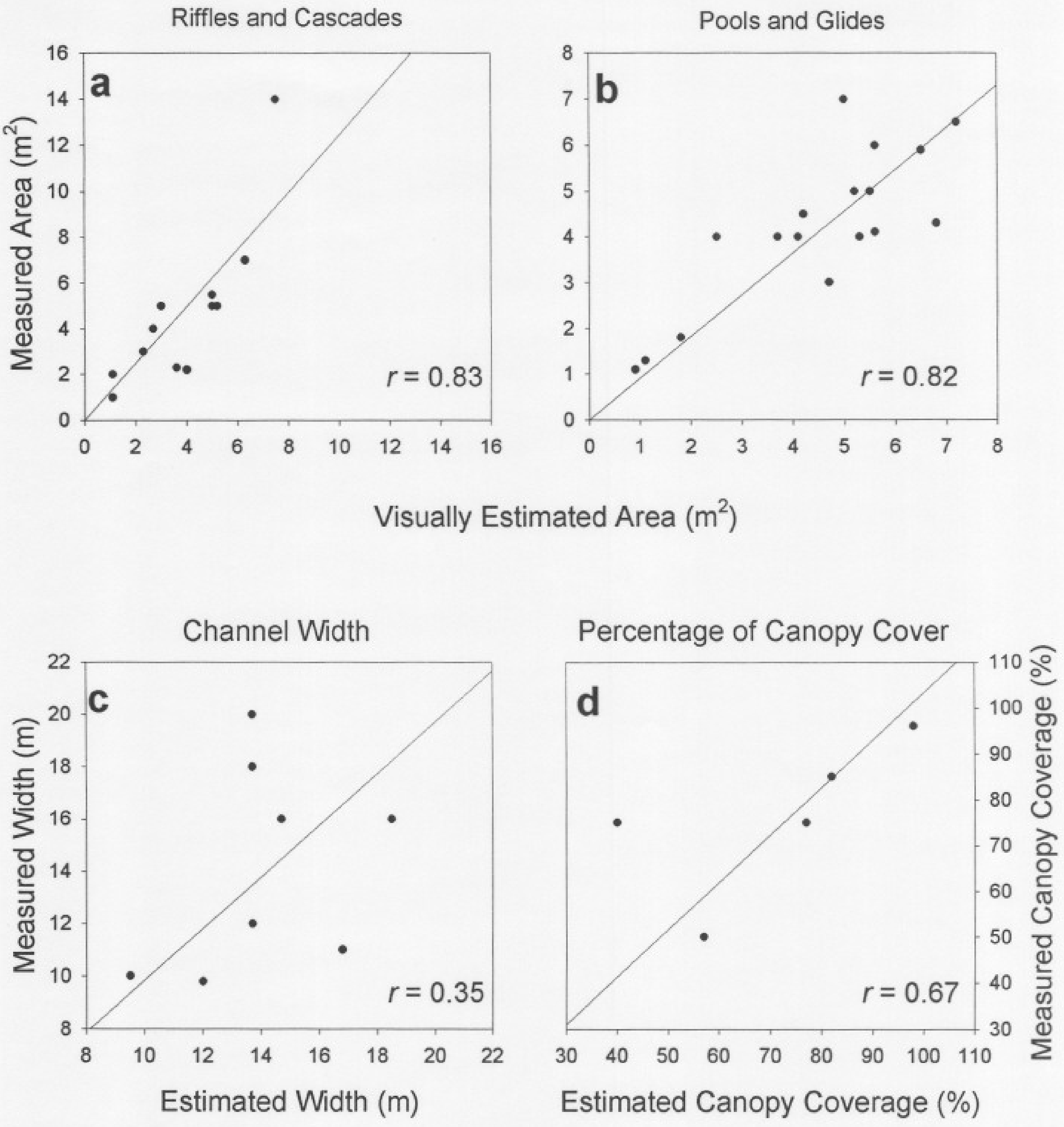


Figure 9. Visual and measured estimates for paired samples of habitat surface (a and b), channel width (c), and canopy cover (d).

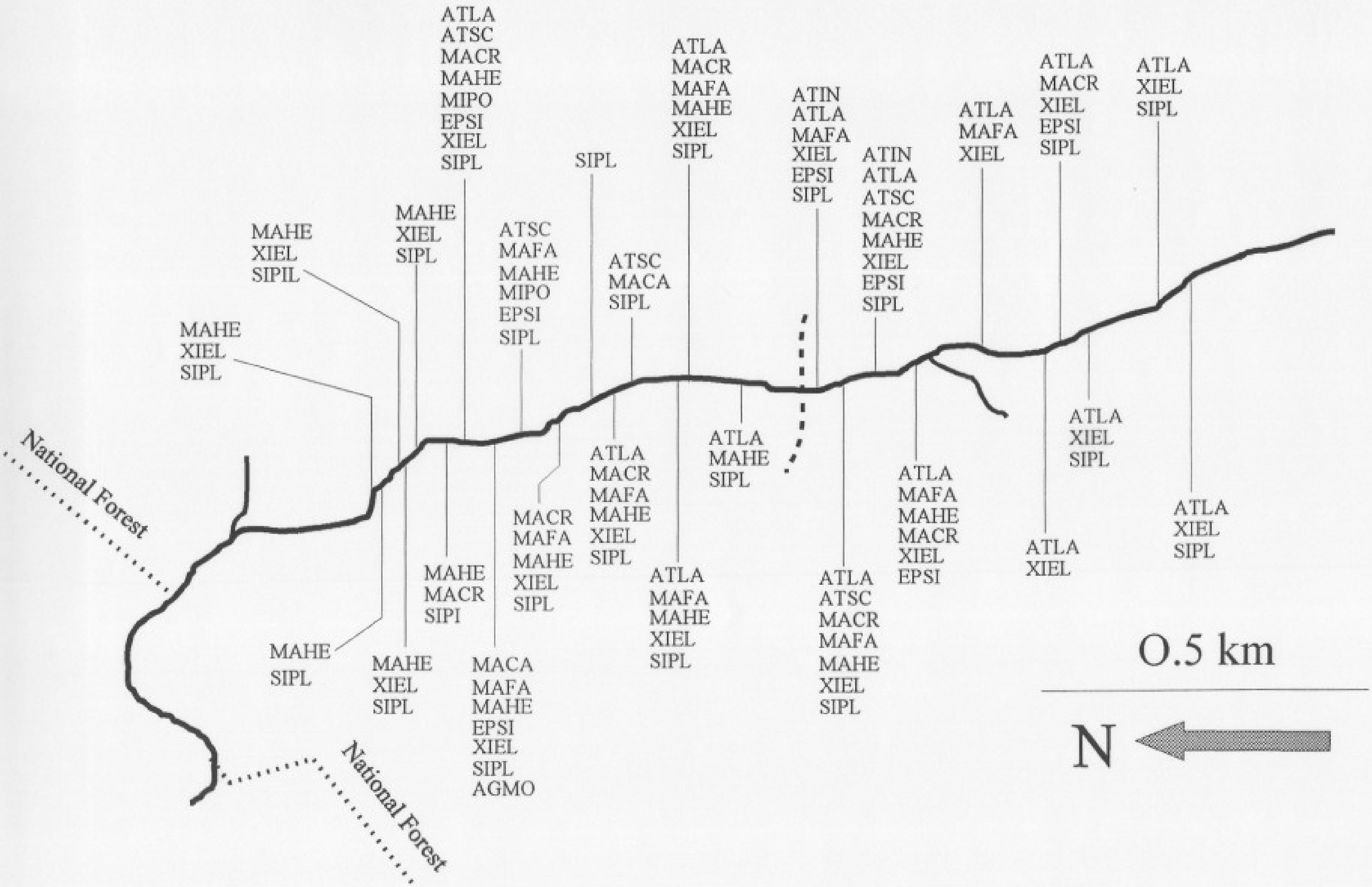


Figure 10. Distribution of target species in Quebrata Jimenez. Species abbreviations are given in Table 1.

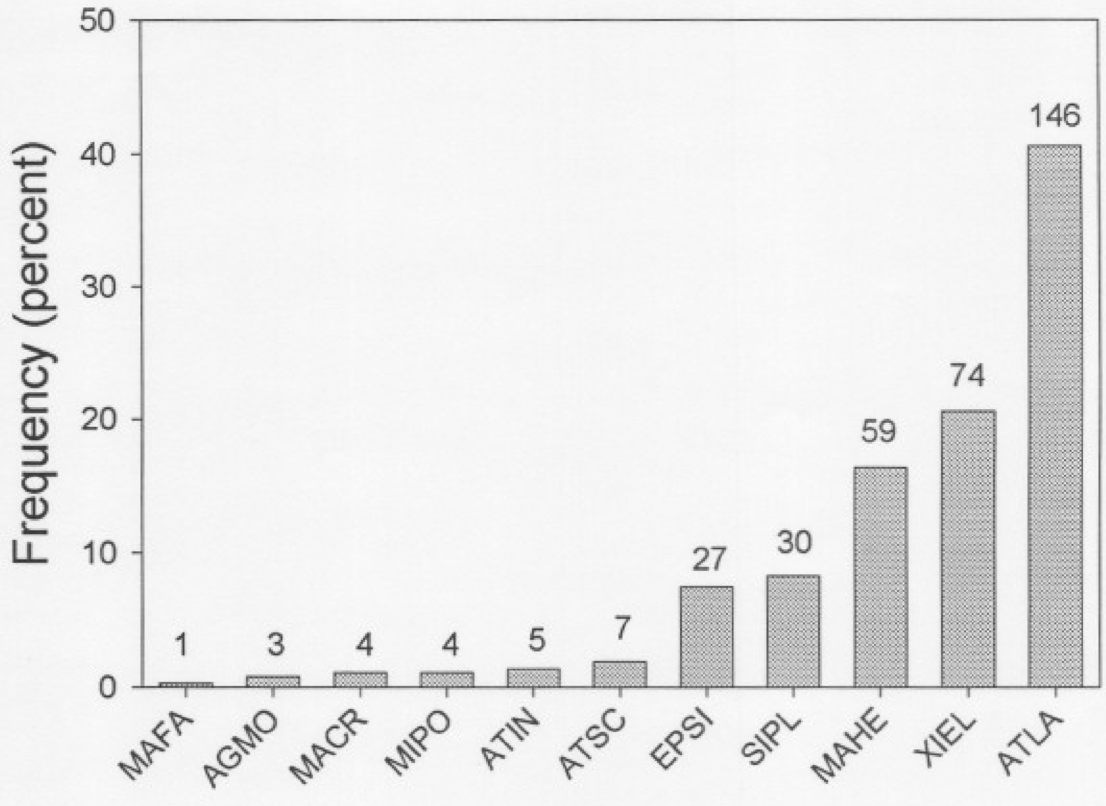


Figure 11. The percentage of the total number of each species captured during the electrofishing survey. The number above the bars show the total number of each species captured. Species abbreviations are given in Table 1.

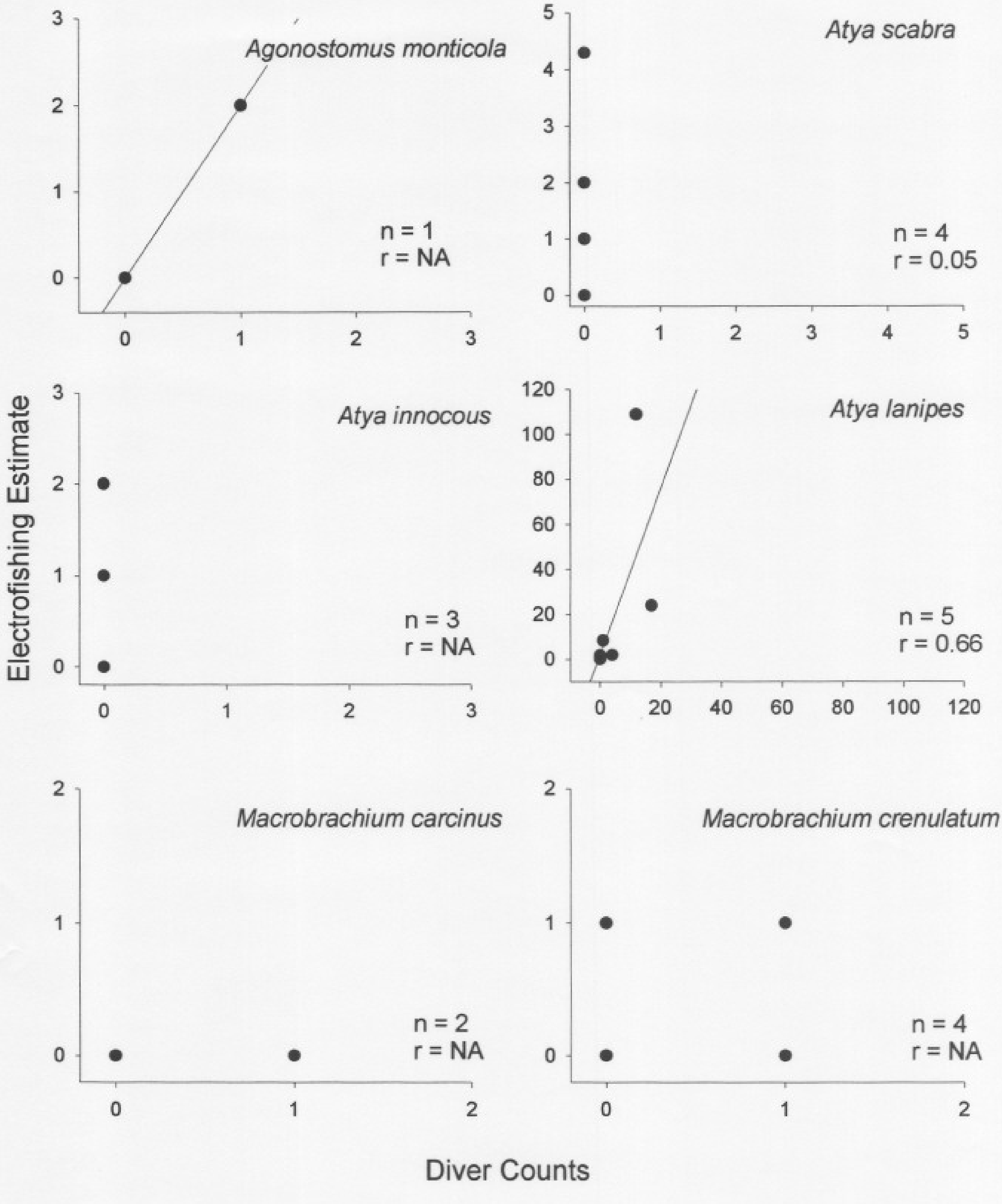


Figure 12. Diver counts and electrofishing results for all target species. NA = not applicable.

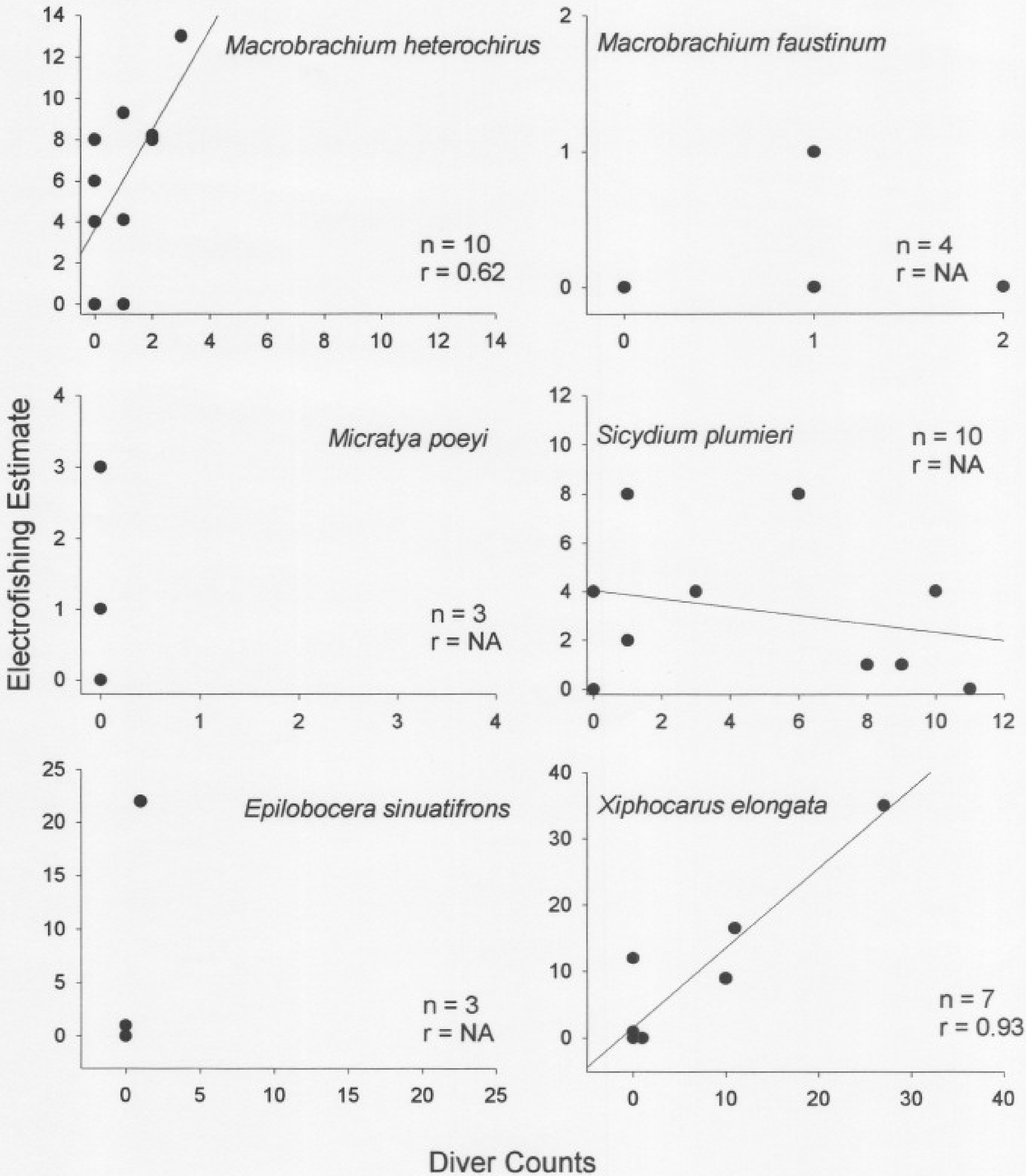
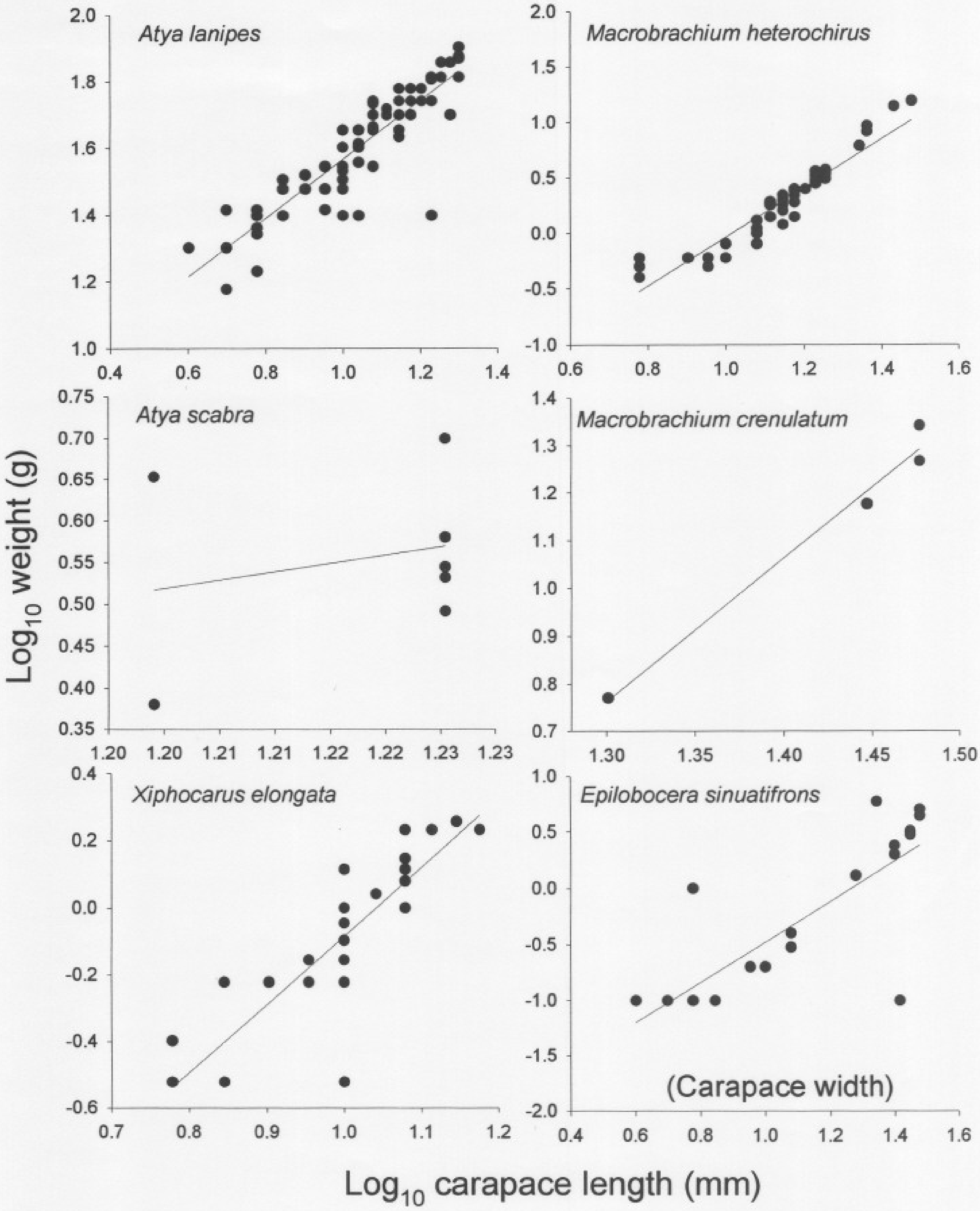
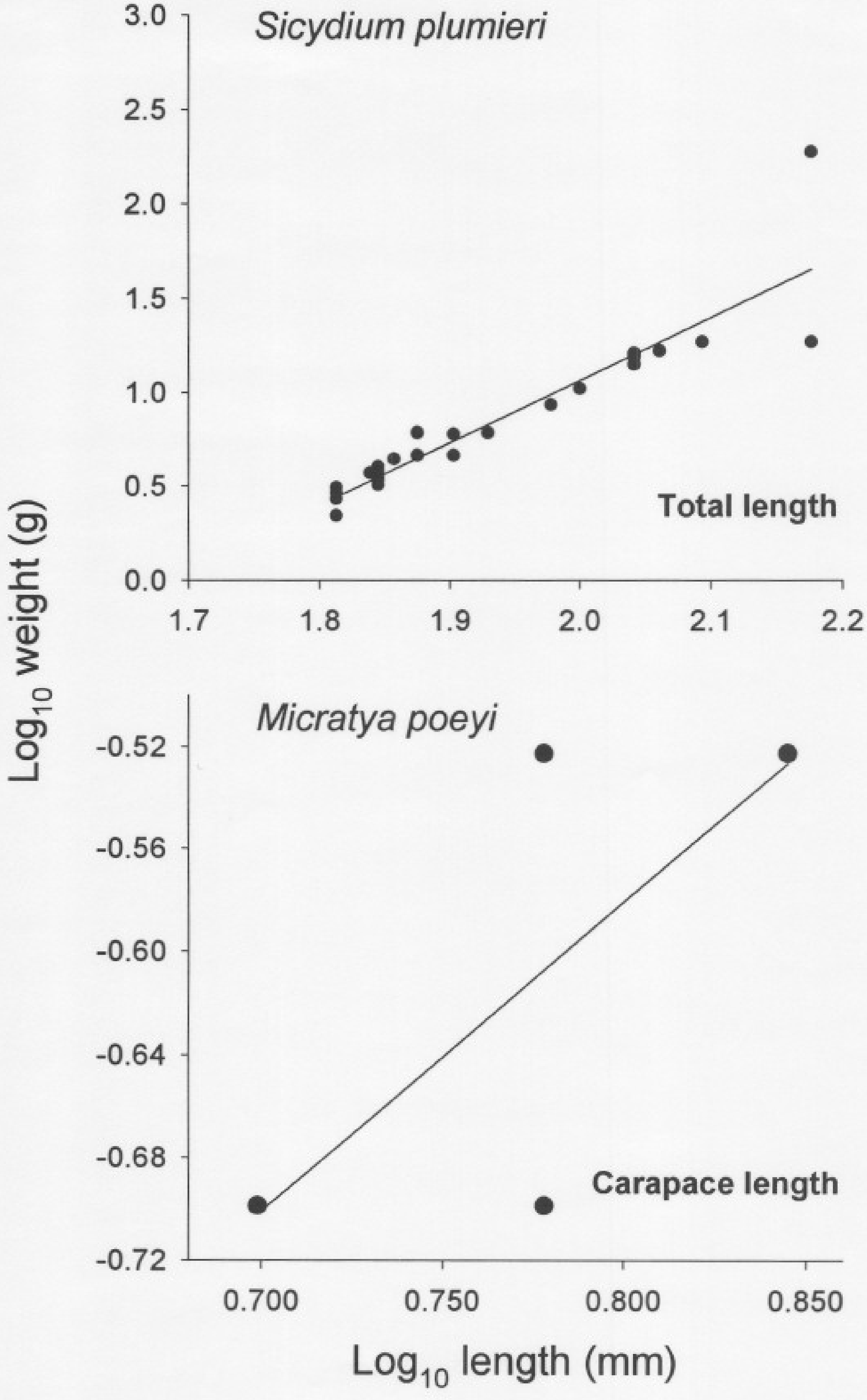


Figure 12. Continued.



Appendix A. Length-weight relationship, logarithmically transformed ($\log_{10}[W] = a' + b' \log_{10}[L]$), for target species captured during the electrofishing survey. Note that x-axis is carapace width for *E. sinuatifrons*.



Appendix A. Continued.