INTRODUCTION

This chapter is dedicated to the analysis of potential errors that could be associated with the MesoHABSIM model, as well as their possible influence on the conclusions of this study. This sub-study was prompted by concerns raised by resource agencies when introduced to our modeling technique. In the entire process, three potential sources of error have been identified:

1.) limited precision during fish data collection
2.) bias due to subjectivity during the visual estimation of habitat attributes
3.) use of conservative measures in defining habitat suitability

It is frequently asked how the pre-exposed grid approach to electro-fishing (Bain et al, 1985) compares to the more standard approach, in which 100-meter-long sites are blocked with nets and fished three times to ensure accurate densities. In August 2002, we had the opportunity to test and compare the two methods, as a USGS team sampled a portion of the Stony Clove using the standard approach, just two weeks after we had conducted a grid-sampling survey of the same area.

Another common concern associated with our study has to do with the subjectivity involved in estimating habitat attributes. This criticism does not question the descriptive advantage of using human observation instead of strictly quantitative measurements; numbers obviously cannot describe the character of a hydro-morphological unit as well as trained personnel. Skepticism instead lies in the possibility of two different surveyors describing a given unit differently. Indeed, discrepancies between surveyors could have a detrimental effect on our study, as three teams mapped different parts of Stony Clove Creek simultaneously.

Our classification system, which divides hydro-morphological units into 11 categories, is designed to limit the error generated by such qualitative methods by additional measurements of hydraulic attributes. To assess the effectiveness of this system and address the possibility of estimation bias, we conducted a calibration exercise in which three teams of two surveyors mapped the stretch of river during the same day.

The subsequent analysis of data collected during this survey allowed us to also address the third issue listed above, which refers to the use of strict, binary criteria to determine habitat suitability (suitable/not suitable) instead of the more standard Weighted Usable Area approach. MesoHABSIM uses binary criteria as a more conservative measure, which is easier to interpret than continuous measures. The differences between the two approaches become more apparent during data analysis, when one might question whether or not conservative criteria ultimately reduces model precision. We were able to measure these differences through a statistical analysis of the final results yielded by each technique.

METHODS

To estimate the accuracy of the grid-sampling technique, we compared densities of fish species captured in 300 grids with the preliminary data collected by USGS in August 2002. The USGS data were collected approximately two weeks after our survey, in an area designated for future restoration (Management Unit 8) that corresponds to our fishing Site 4. During this survey, USGS personnel electro-shocked within three sein-blocked 100-meter-long (700-850 square meter) reaches, repeating each pass three times, to ensure thoroughness. They then calculated fish densities and biomass using the Moran-Zippin method of proportional reduction (Baldigo pers. comm.). We compared the average densities from this survey with the densities calculated from the 54 grids we sampled in Fishing Site 4, as well as with the average densities we calculated for the entire Stony Clove Creek (269 grids). We used graphic representation, correlation and paired t-test methods to compare species-specific densities.

At the beginning of the MesoHABSIM habitat survey, we trained the technical staff of the Greene County Soil and Water Conservation district was in habitat mapping. As part of this training process, we conducted a calibration exercise on July 7th, 2002. Three survey teams (consisting of GCSWCD and Cornell staff) mapped approximately 400 meters at the top of Management Unit 1. We explained the details of the data collection technique prior to the survey. Each team mapped the river, maintaining a considerable distance from the others. Two teams used a GPS unit to define management unit boundaries. Each team entered data into a GIS database; using previously-calculated rating curves (see Chapter 2.3.5.3) we were therefore able to calculate a species-specific probability of presence and abundance for each habitat unit. The area of the unit was than multiplied by the average of both probabilities (presence and high abundance) to calculate Probability Weighted Usable Area (PWUA). The sum of PWUA's availability for each species in the site was subsequently used to compute the community habitat structure. We analyzed the resulting habitat structure (i.e. the proportion of habitat available for the species) for discrepancies between the three teams. We used graphic representation, correlation and paired t-test methods to determine if and to what extent the habitat structures resembled each other. We performed a second comparison using Suitable Area instead of PWUA. In this case, we counted only the area of the units having probabilities of presence greater than 0.5 (without weighting by probability).

To further measure the accuracy of our methods, we investigated the use of Suitable Area versus PWUA. Variation between techniques could manifest itself in the study's conclusions in two ways: first, each method could produce a differently-shaped habitat rating curve (i.e. the values do not exhibit a linear correlation), or second, the proportions of species-specific habitat in the community structure might not be identical. The latter could result from, for example, one species having a large amount of low-quality habitat with probabilities below 0.5 and minimal high-quality habitat. In such situations, one method could produce much higher habitat values than the other, but still preserve the same rating curve shape. To perform this portion of the comparison, we computed the PWUA for all sections. First, we analyzed the correlation between all habitat predictions (for all management units and for all interpolated flows). As differences could be the result variation among species in terms of adaptability to sup-optimal habitat conditions, we computed correlations for every investigated species separately. We then calculated community structure at each investigated flowusing PWUA and compared it to the previously determined structure obtained using Suitable Area (see Chapter 2.3.5.3). Eventually, we made a graphical comparison of the PWUA-based community structure to the proportions of species captured during our survey, as well as to the target community structure.

RESULTS

Figure A5:1 shows the average densities of fish species captured in all of the above cases. The USGS data shows very high slimy sculpin densities (2.7 fish per square meter (fpsm)). The second-highest density was that of the brown trout (0.43 fpsm), followed by rainbow trout (0.37 fpsm), and blacknose dace (0.30 fpsm). Longnose dace made up approximately half of the value of blacknose dace (0.13 fpsm). Brook trout, cutlips minnow and white sucker have very low values. The grid survey performed in the same location had a much lower density than slimy sculpin (0.4 fpsm), but brown trout is still the second most common species with similar densities (0.33 fpsm). Rainbow trout and blacknose dace are found only half as frequently as in the USGS survey (0.14 and 0.11 fpsm, respectively), although longnose dace is twice as frequent (0.29 fpms). Brook trout and cultlips minnow also have very low densities, but the densities of white suckers are slightly higher than those of the USGS survey. The density-distribution in the third group (all Stony Clove fishing data) was very similar to that of the second (Site 4 fishing data only). Only a few fish (of species bluegill, pumpkinseed and spottail shiner) were exclusively in group three; these fishes do not appear in the chart. For all groups, the densities are clearly very similar (with the exception of slimy sculpin density in the USGS data set). The paired t-test proves that no significant difference exists between any of the samples, even including slimy sculpin data ($p > 0.05$), (see Figure A5:2).

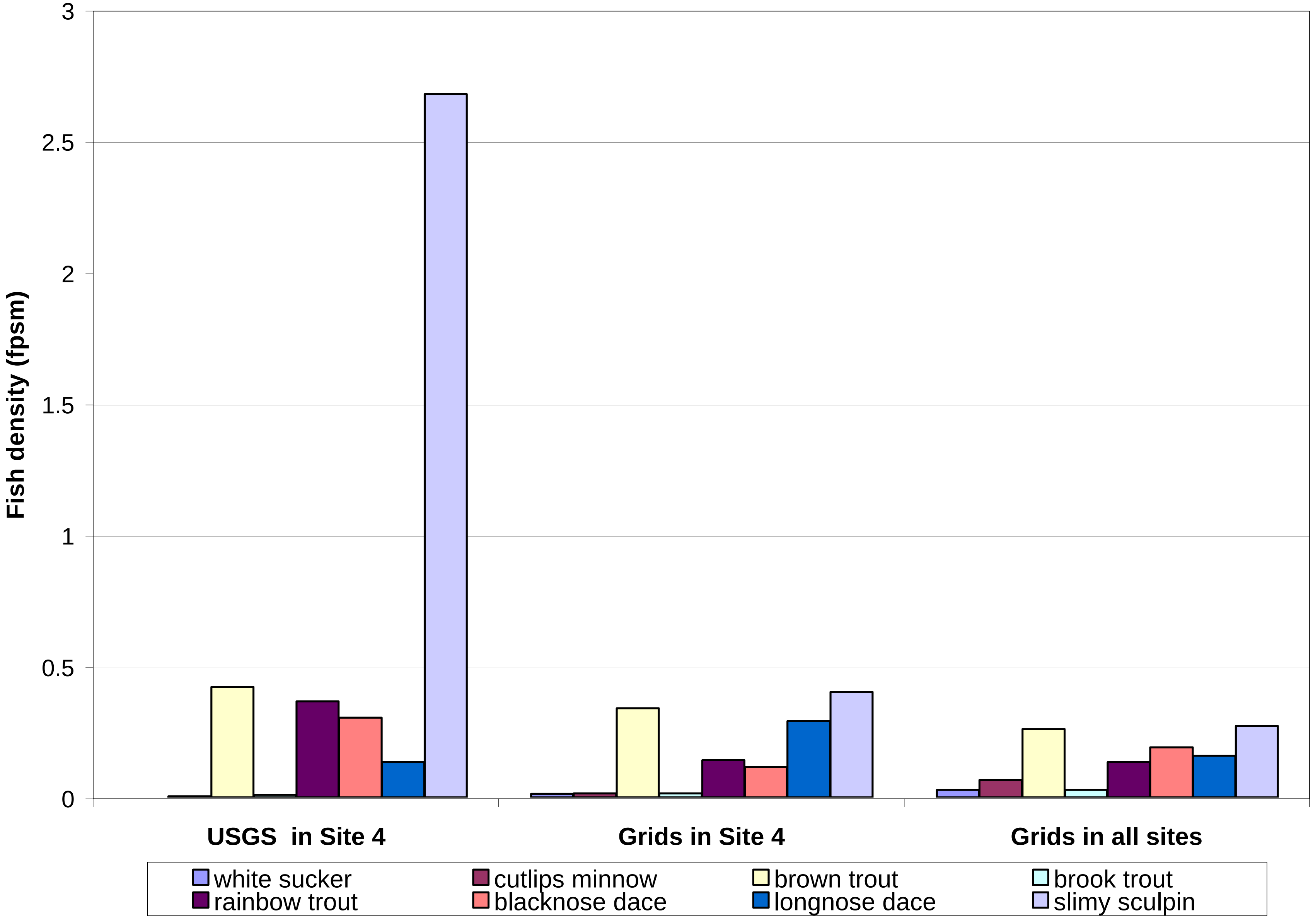
Figure A5:3 presents maps of the hydro-morphological units produced by each of the three teams. Team A mapped a total area of 1212 m^2 and identified 17 units (7 riffles, 3 pools and 3 ruffles, 2 runs, 1 cascade and 1 glide). Team B mapped an area of 1255 m^2 containing 20 units (6 runs, 5 ruffles, 3 pools, and 2 rapids, 2 riffles and 2 side arms). The third team identified an area of 1232 m^2 with 18 units (6 riffles, 5 ruffles, 3 runs, 2 pools, 1 cascade and 1 rapid). Figure A5:4 shows how much of the wetted area has been defined by the model as suitable for the investigated fish species. For slimy sculpin, a similar area value was identified as suitable by each team differing by no more than 12% of the average. The habitat area identified as suitable for other species differed substantially: Team C found much more habitat for both daces and brook trout, while team B did not find any habitat suitable for brook trout or longnose dace. If represented as a community structure (Figure A5:5 (SI rel)), the differences are still very dramatic. These graphs could lead to different conclusions despite the fact that the K-S test of habitat values calculated for each unit did not show any significant differences between the groups ($p=0.081$ $r>0.85$). When plotted using PWUA (Figure A5:6 Wua absolute), however, the differences between the survey results almost disappear. Habitat for all species is represented and the values do not differ by more than 20% of the average. As visible on Figure A5:7 (WUA rel), all three survey teams produced almost identical habitat structures that would certainly lead to similar conclusions. Slimy sculpin habitat is the most dominant, followed by habitat for blacknose dace and white sucker. Brook

increases the contrast and could lead to erroneous results if the survey scale is not sufficiently broad. Furthermore, one must take into account that all three teams were still in the training process; mapping accuracy strongly increased as the survey progressed.

For these reason, the differences between applying Suitable Area and PWUA to fish habitat analyses are minimal at the river scale. This could also be the result inaccuracy associated with the calculation of Suitable Area leveling out at broader scales. In addition to increasing the divergence in probabilities, the fact that the probability cut-off value is not species-specific likely contributes to inaccuracies at smaller scales. That is, species vary in their ability to utilize sub-optimal habitat when optimal habitat is unavailable; this variation among species contradicts the assumption that conditions change from unsuitable to suitable at the same point (0.5 probability) for all species. This distinction can have important implications, in that high quantities of low-quality habitat could outweigh the limited occurrence of excellent areas.

Despite the afore-mentioned inaccuracies, the use of Suitable Area for habitat analysis has certain advantages. First, the results are much easier to interpret than those from a weighted usable area analysis. Second, this approach allows for the easy determination of the amount of habitat available to the entire fish community. This habitat is defined as the sum of all areas suitable for one or more species in the community. The absence of a cut-off value when using weighted usable areas, makes the distinction between good and bad habitat somewhat ambiguous. As our analysis has shown, Suitable Area and PWUA are generally interchangeable at the large scale. We can therefore justify the use of Suitable Area for river-wide analyses, as it provides more conservative results that are easier to communicate. At the site level (i.e. when used for detailed planning and the evaluation of restoration measures), however, the PWUA calculation provides a more precise measurement and should be applied when appropriate[1].

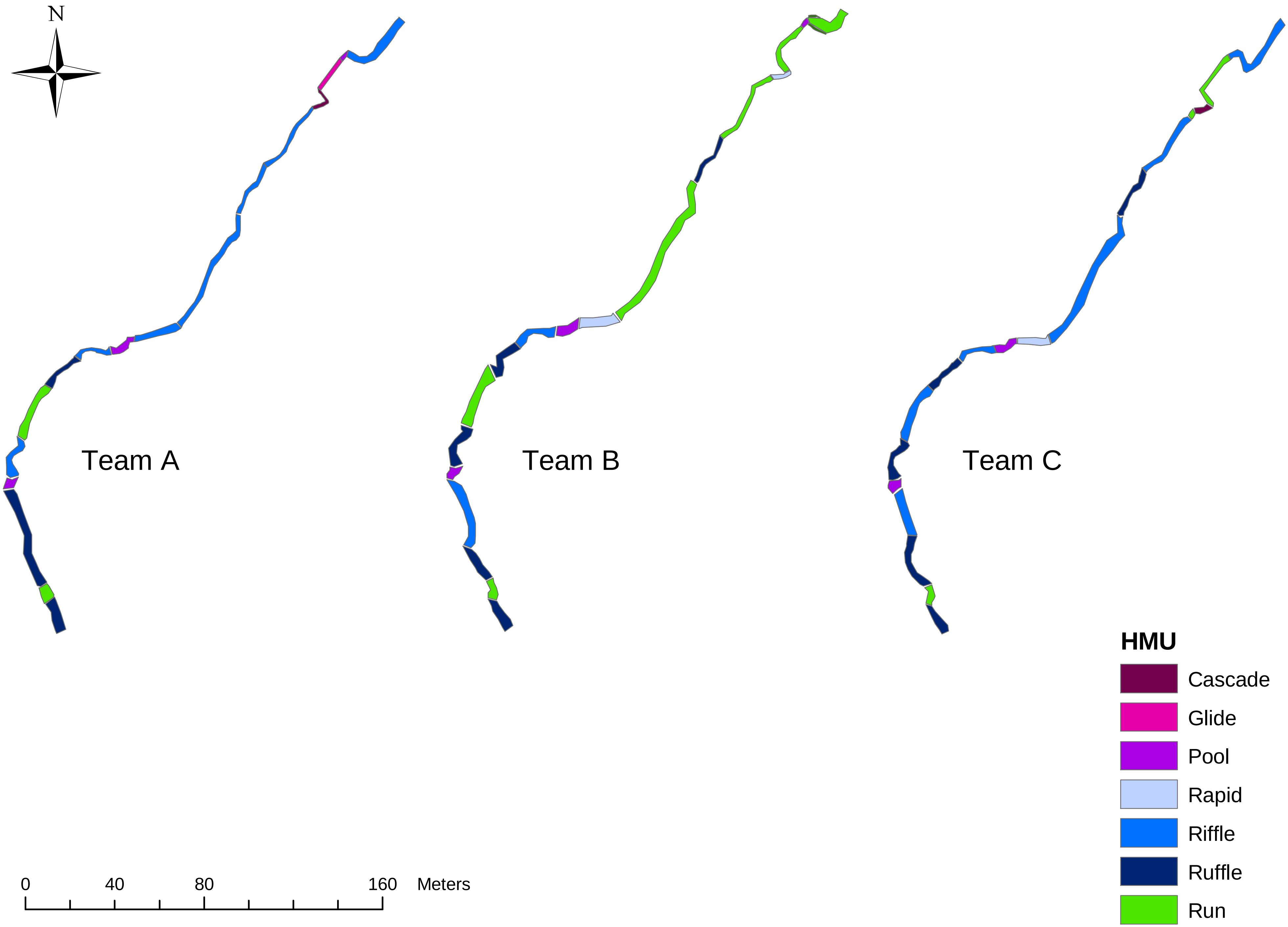
[1] This fact did not affect the simulation of brook trout habitat improvements to any great extent, as we found the Stony Clove brook trout population to be highly specific in habitat selection; calculated probabilities were either very high or very low. That is, very little useable brook trout existed that was not of optimal quality. The cut-off value of 0.5 should therefore function well in differentiating between good and bad habitats.



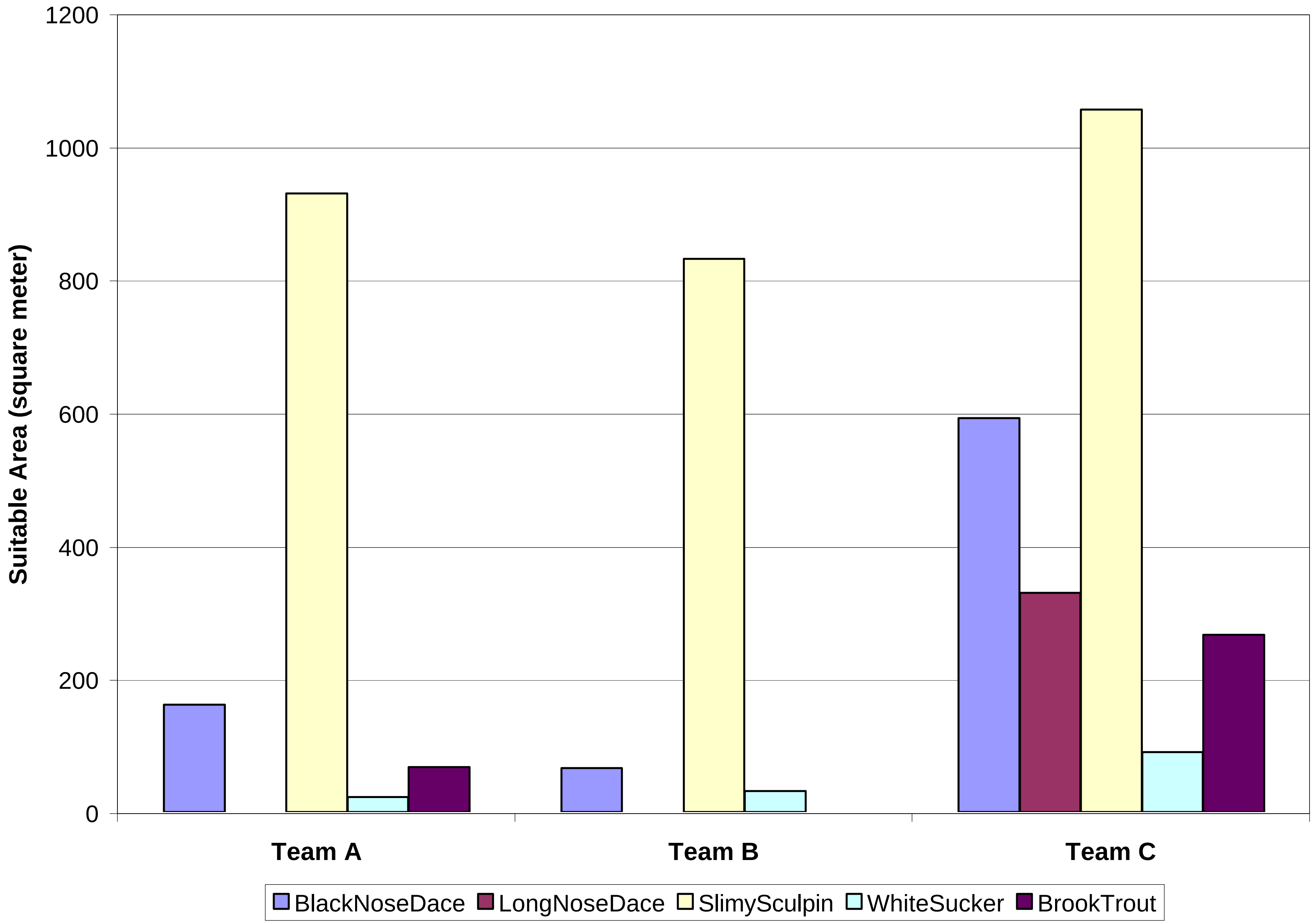
A5:1 Average densities of fish species captured in Site 4.

Correlation between PWUA and Suitable Area		
	r	**p**
Blacknose dace	0.981	0.000
Longnose dace	0.989	0.000
Slimy sculpin	0.982	0.000
White sucker	0.989	0.000
Brook trout	0.95	0.000

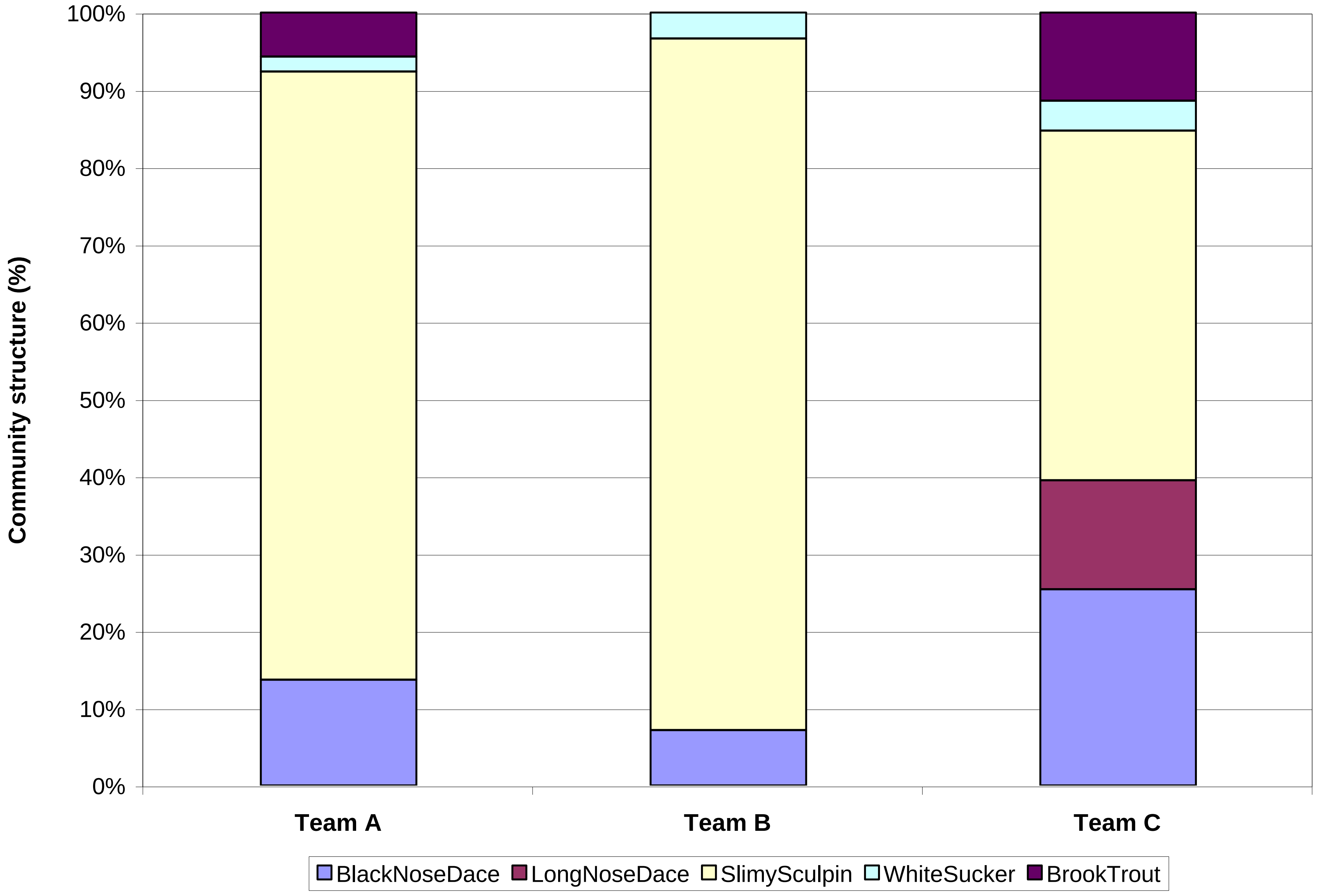
A5:2 Correlation between PWUA and Suitable Area



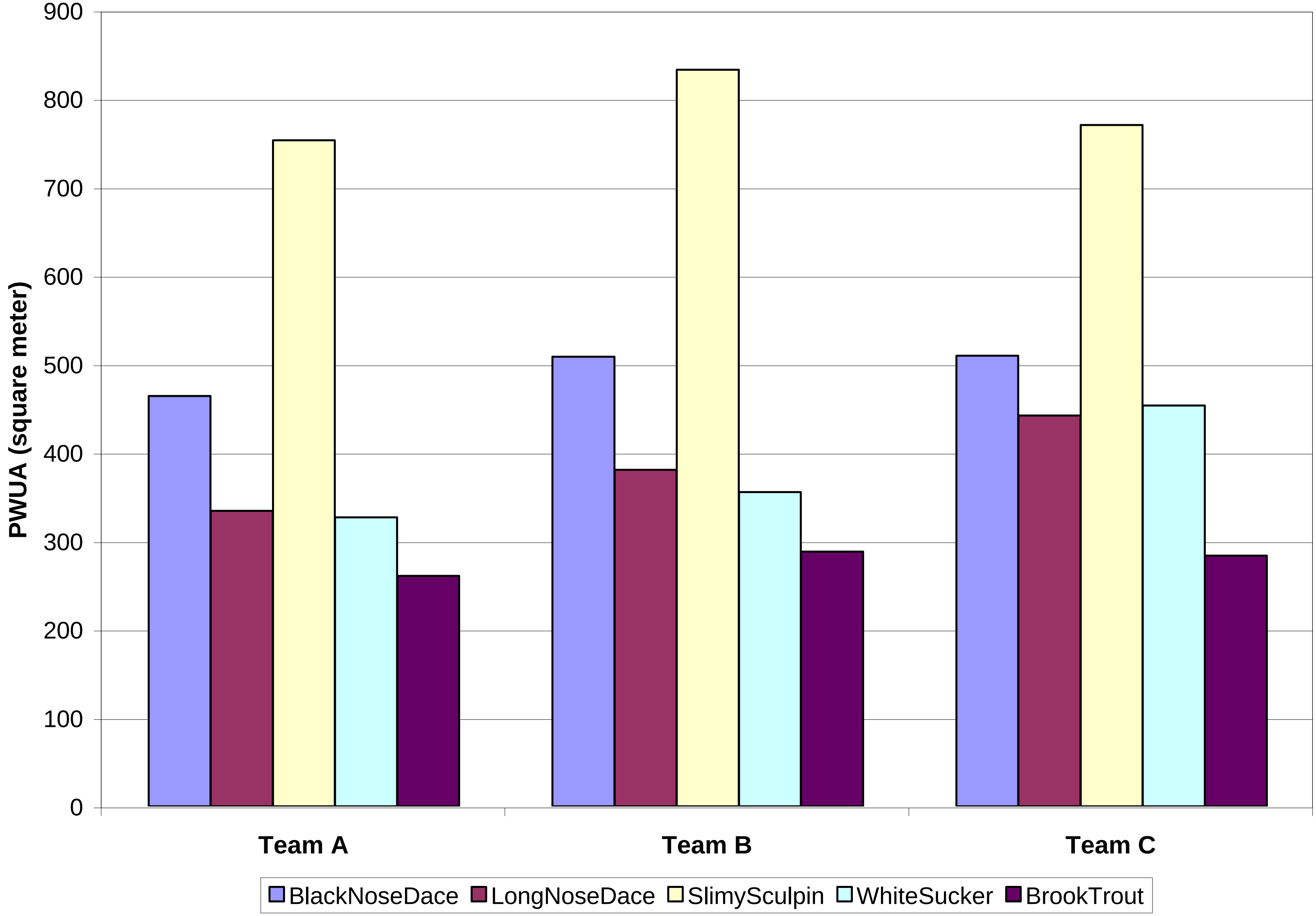
A5:3 Hydromorphologic units produced by each of the three study teams.



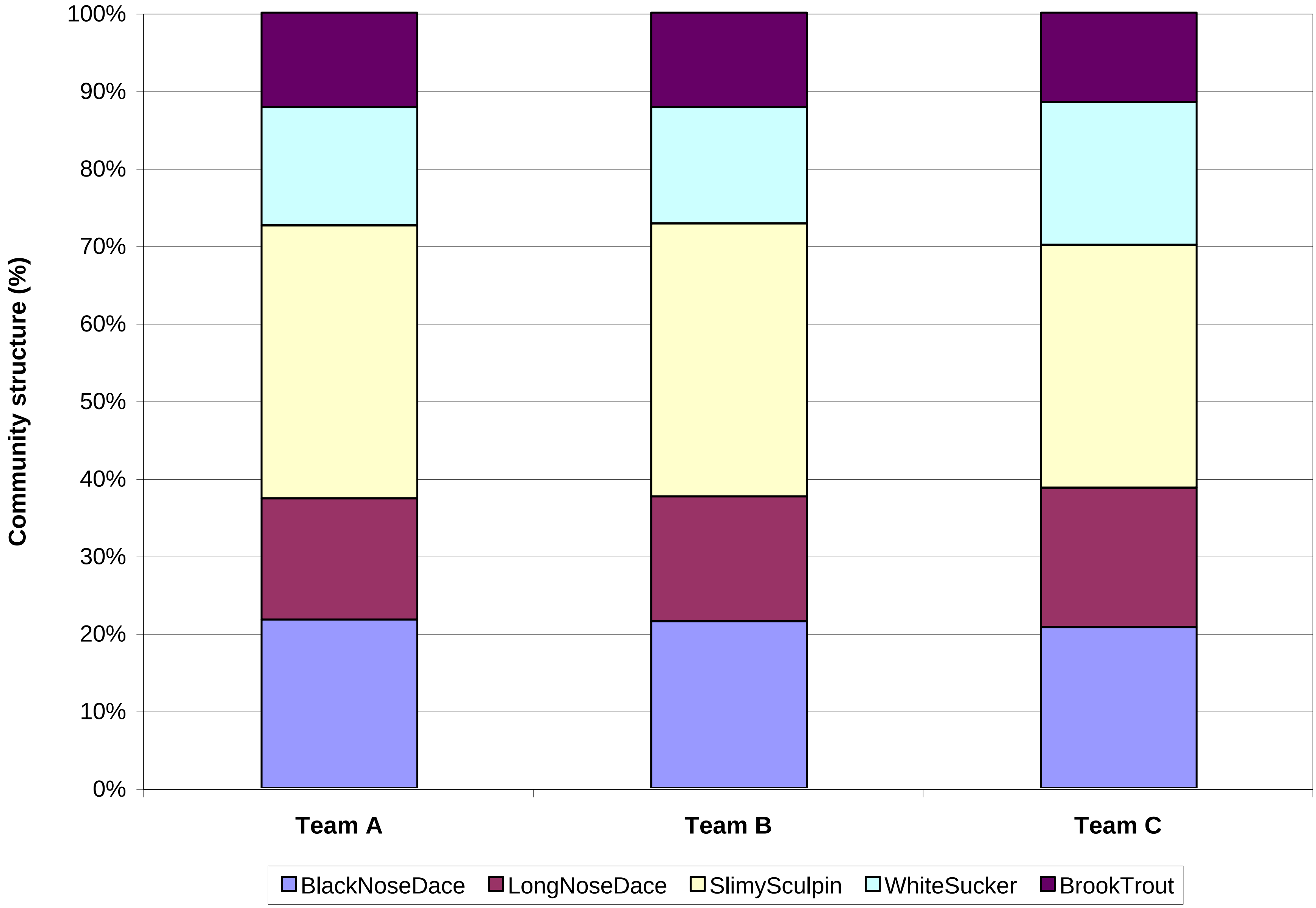
A5:4 Suitable Area as defined by the model and mapped by the three teams.



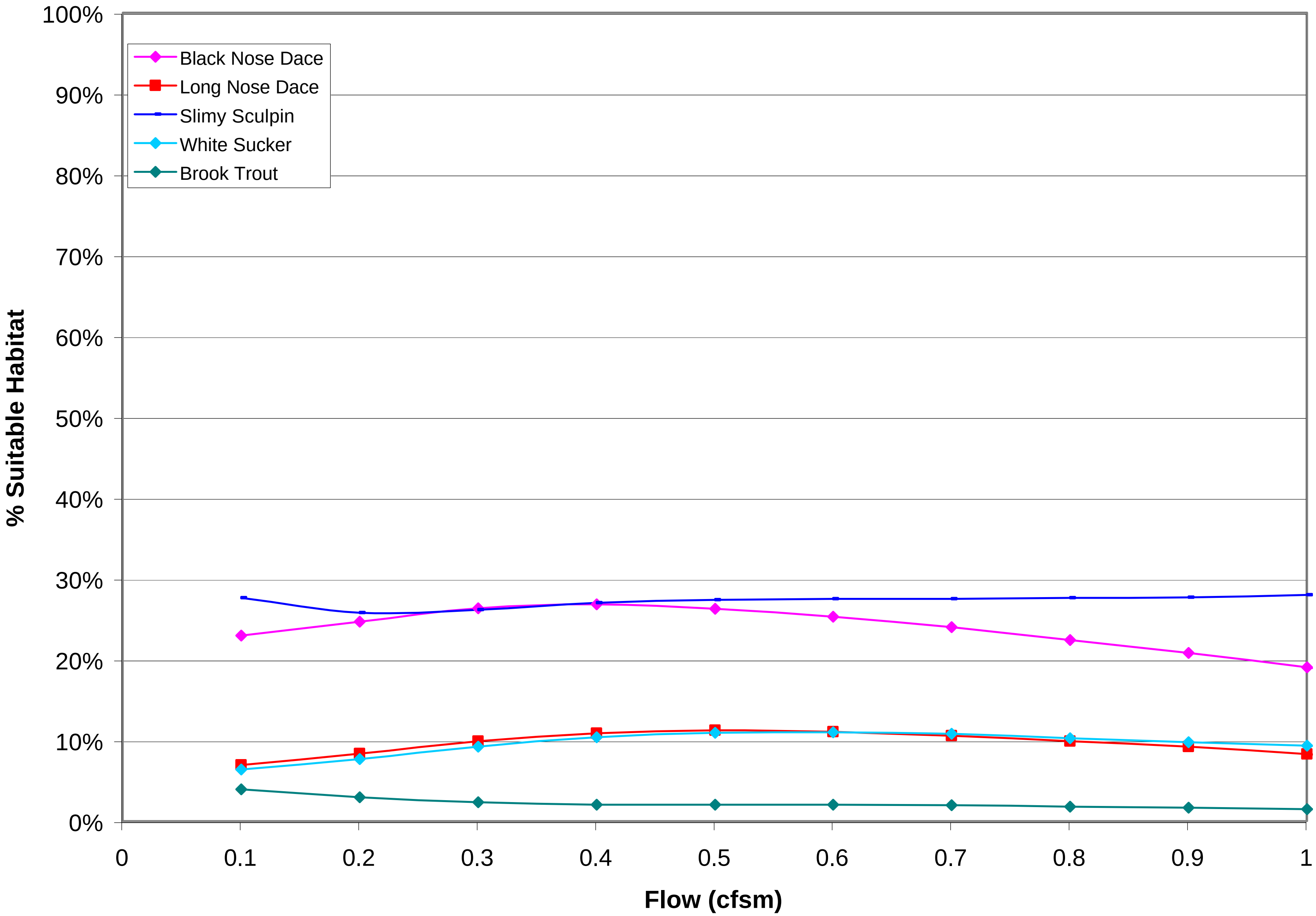
A5:5 Community habitat structure as mapped by the three teams.



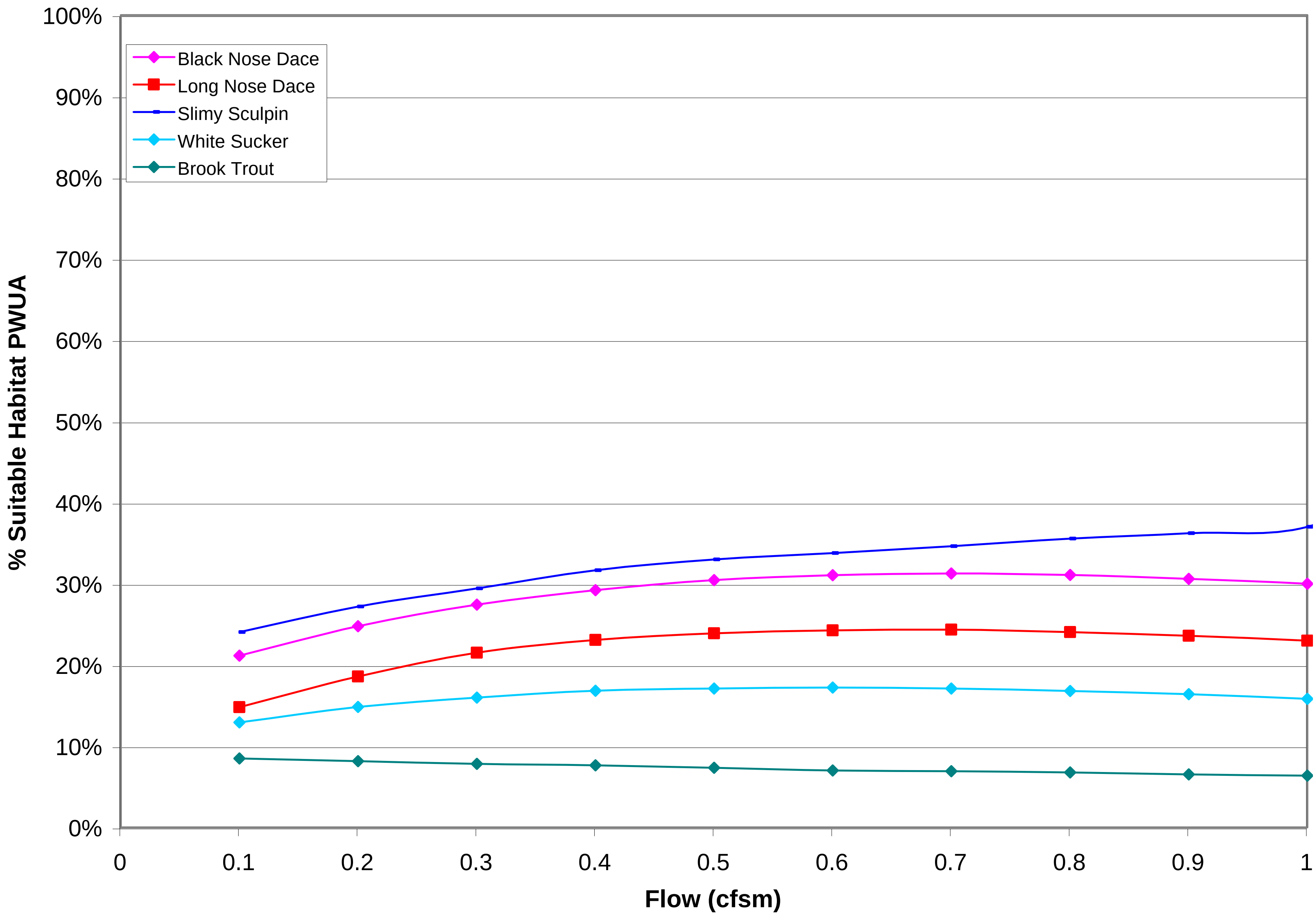
A5:6 PWUA as mapped by the three teams.



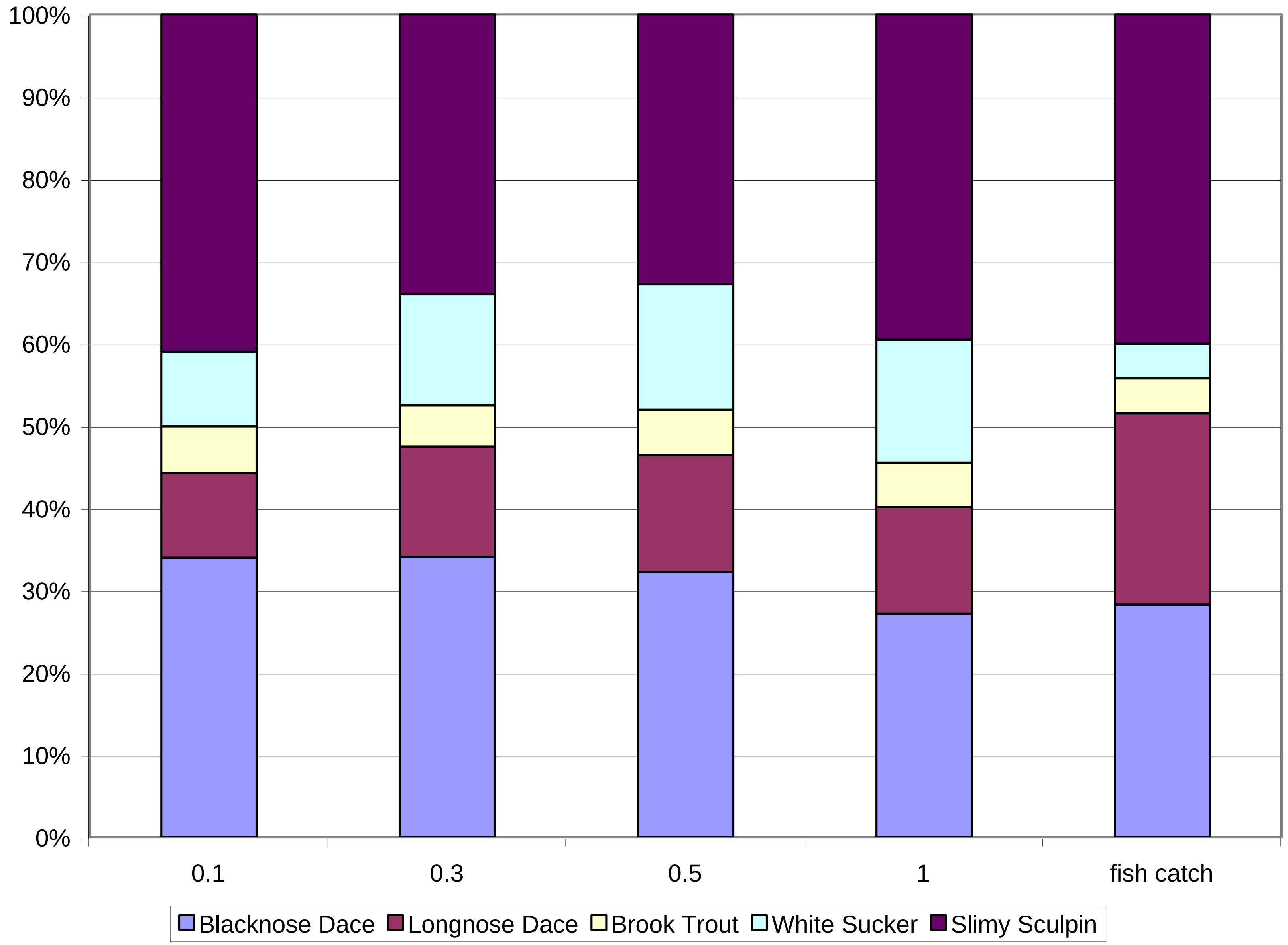
A5:7 Community habitat structure using PWUA



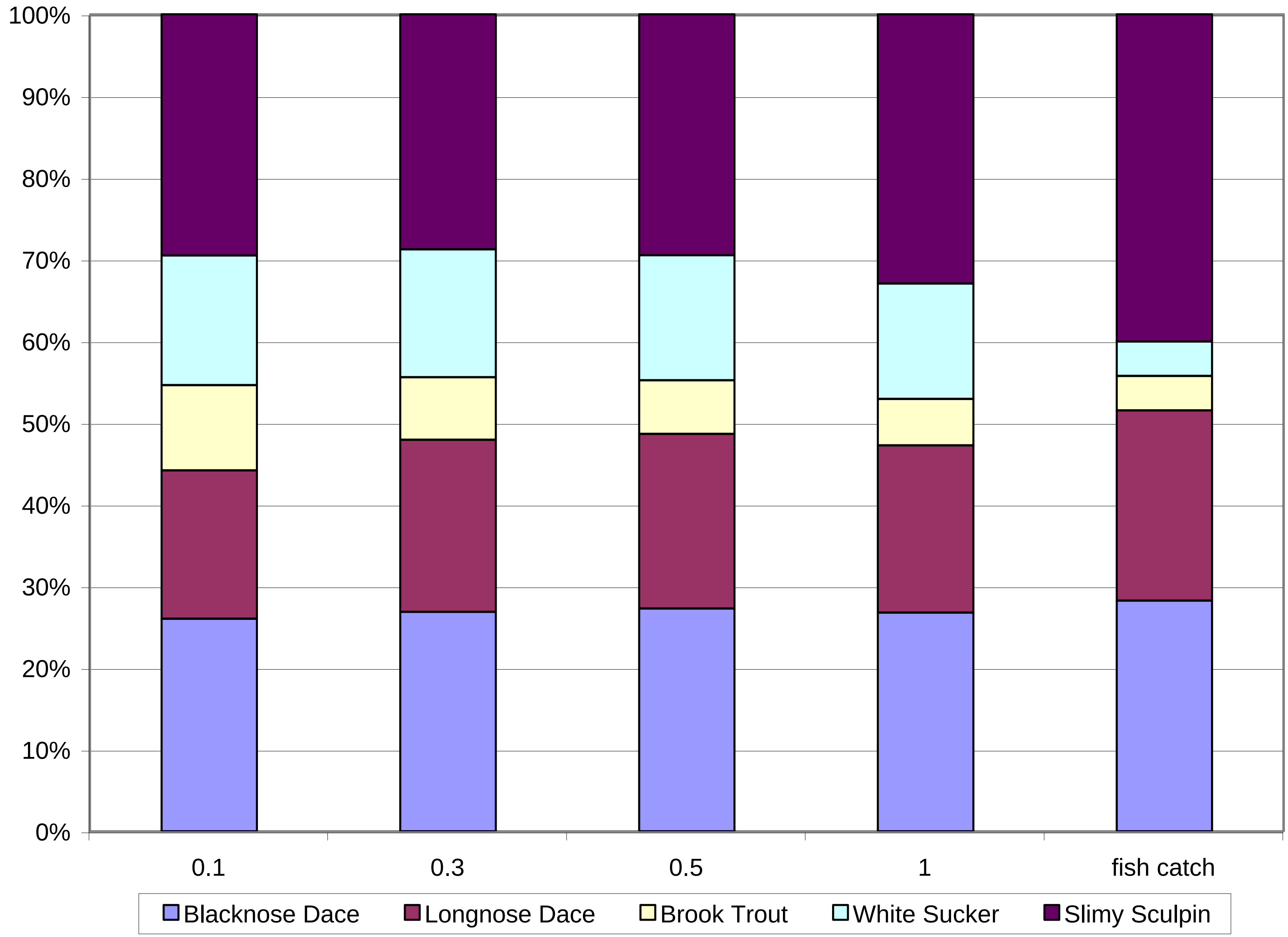
A5:8 Flow versus suitable habitat (Suitable Area)



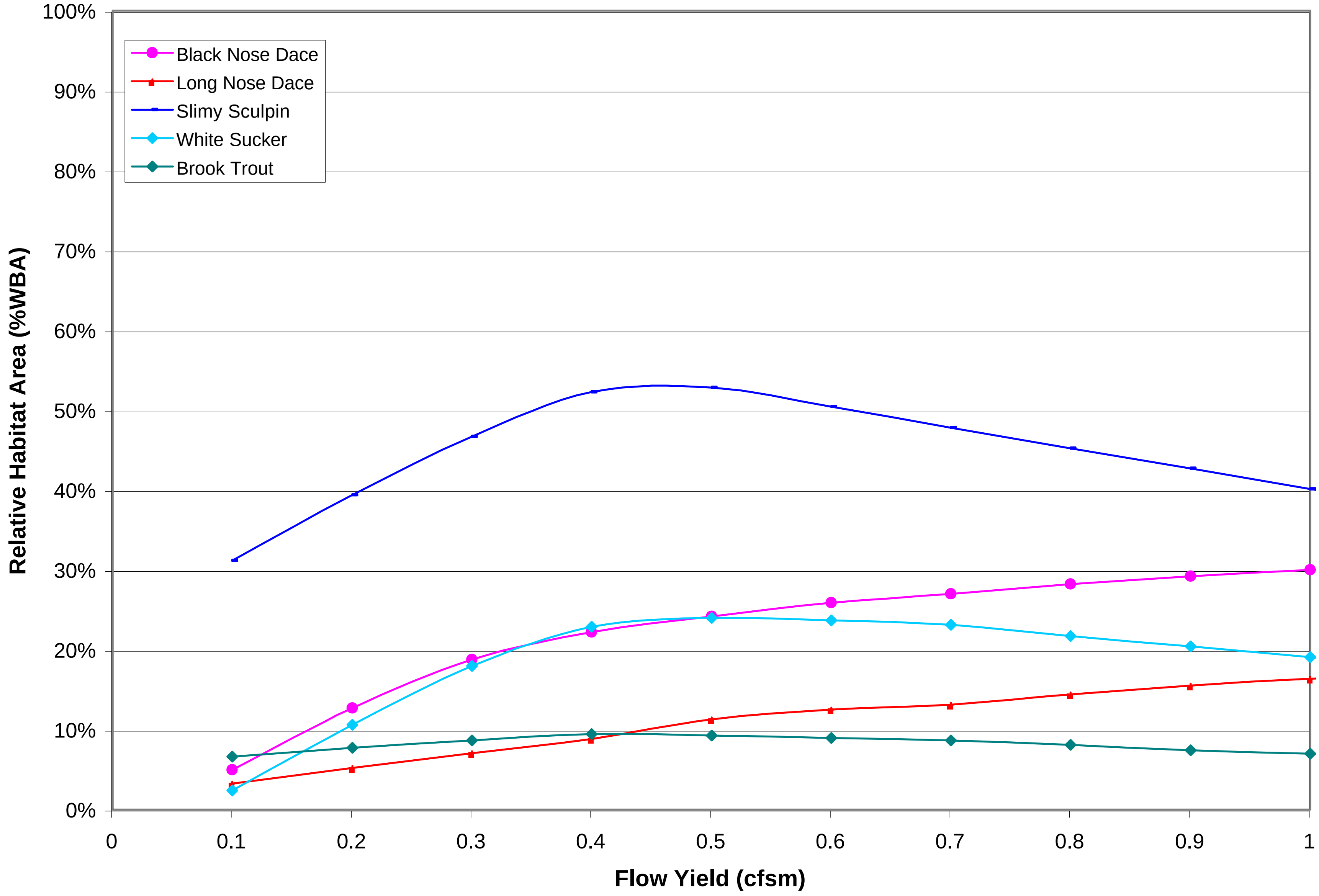
A5:9 Flow versus suitable habitat (PWUA)



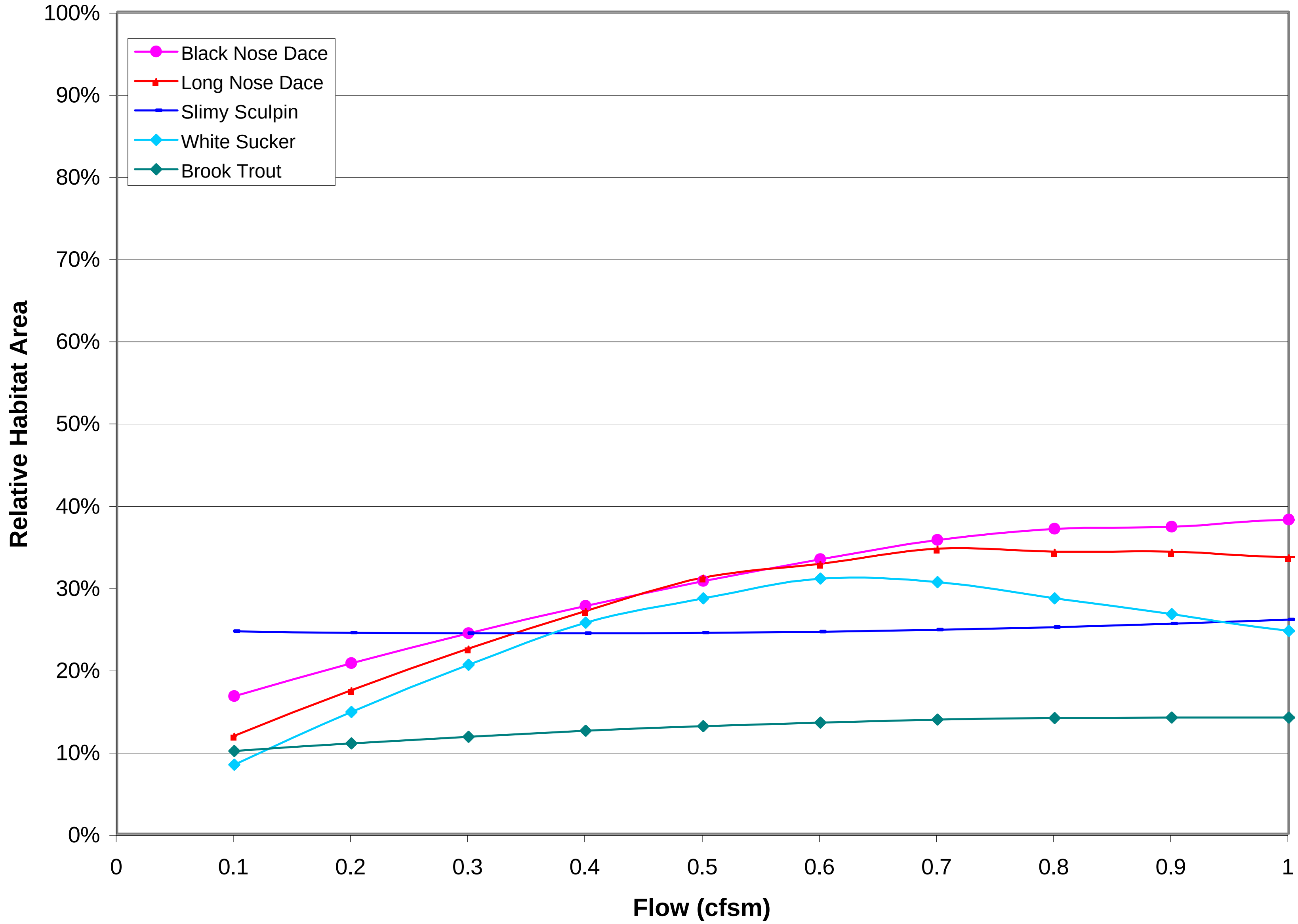
A5:10 Community habitat structure (Suitable Area)



A5:11 Community habitat structure (PWUA)



A5:12 Habitat rating curve for Management Unit 6 (Suitable Area)



A5:13 Habitat rating curves for Management Unit 6 (PWUA)