

**Part V: Scoring Criteria for the Index of Biotic Integrity and
the Index of Well-Being to Monitor Fish Communities in
Wadeable Streams in the Coosa and Tennessee River Basins of
the Blue Ridge Ecoregion of Georgia**

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Introduction

The Blue Ridge ecoregion (BRM), one of Georgia's six Level III ecoregions (Griffith et al. 2001), forms the boundary for the development of this fish index of biotic integrity (IBI). Encompassing approximately 2,639 mi² in northeast Georgia, the BRM includes portions of four major river basins — the Chattahoochee (CHT, 142.2 mi²), Coosa (COO, 1257.5 mi²), Savannah (SAV, 345.3 mi²), and Tennessee (TEN, 894.2 mi²) — and all or part of 16 counties (Figure 1). Due to the relatively small watershed areas and physical and biological parameters of the CHT and SAV basins within the BRM, and the resulting low number of sampled sites, IBI scoring criteria have not been developed for these basins. Therefore, only sites in the COO and TEN basins, meeting the criteria set forth in this document, should be scored with the following metrics.

The metrics and scoring criteria adopted for the BRM IBI were developed by the Georgia Department of Natural Resources, Wildlife Resources Division (GAWRD), Stream Survey Team using data collected from 154 streams by GAWRD within the COO (89 sites) and TEN (65 sites) basins. Fish communities in streams with watershed areas less than one square mile cannot be assessed using this SOP due to inherently low diversity within headwater streams. Benthic macroinvertebrate assessments may serve as an alternate biological assessment tool for these streams (contact GA Environmental Protection Division (GAEPD) at 404-675-1646 for guidance regarding the appropriateness of benthic macroinvertebrate assessment).

The GAWRD collected a total of 88 of the 108 species known to inhabit wadeable BRM streams in the COO and TEN basins (Appendix A). Species of concern in the BRM include one federally endangered species (Etowah darter, *Etheostoma etowahae*), three federally threatened species (blue shiner, *Cyprinella caerulea*; goldline darter, *Percina aurolineata*; Cherokee darter, *Etheostoma scotti*), one federal species of concern (sicklefin redhorse, *Moxostoma* sp.), and 21 state-listed species (GAWRD—Nongame Conservation Section, 2010; Table 1).

Inherent differences in species richness warranted separate scoring criteria for the COO and TEN basins. Scoring information related to tolerance rankings, feeding guilds, and

species categories are included in Appendix A. Table 2 shows the scoring criteria developed for the thirteen BRM IBI metrics (for metric descriptions refer to GAWRD 2005, Part I, <http://www.georgiawildlife.org/node/913>). Maximum Species Richness (MSR) graphs are included in Appendix B.

Scores for the BRM IBI ranged from 12 to 56 (potential range 8 to 60) with a median of 36. Based on IBI classes (GAWRD 2005, pg 40), 12 (10 COO, 2 TEN) sites ranked EXCELLENT, 37 (22 COO, 15 TEN) ranked GOOD, 45 (26 COO, 19 TEN) ranked FAIR, 39 (18 COO, 21 TEN) ranked POOR, and 21 (13 COO, 8 TEN) ranked VERY POOR. Fish abundance data was standardized for each site, and sites were grouped based on community similarities. We used Primer 6.0 statistical software for ecological data to determine Bray Curtis similarities between sites (Clarke and Gorley 2001; Clarke and Warwick 2006). We categorized each site by basin and IBI class as determined by the metrics presented here, and averaged fish community data across these categories. Figure 2 illustrates the relative ability of the current metrics to separate sites based on fish community health. The modified Index of well-being (Iwb) scores for the BRM (Table 3) ranged from 2.8 to 9.7 with a median of 7.5.

Regional Diversity

High elevation and high gradient watersheds are common in the BRM, and fish diversity is relatively high when compared to other ecoregions in Georgia. However, some BRM streams represent unique systems where high elevation effects (e.g., cooler water temperatures, widely fluctuating flows, and steep gradient) pose insurmountable barriers to colonization by many fishes. These characteristics are common in high elevation streams throughout the Appalachian Mountains and often result in low fish diversity. Therefore, 27 COO and TEN sites were excluded from this analysis in addition to the BRM sites located in the CHT and SAV basins. We designated these 27 sites as high-elevation/trout-dominated (HETD) streams.

The IBI is designed to assess biotic integrity through the use of fish community metrics representing species richness, species composition, trophic composition, and fish abundance and condition (Fausch et al 1984). Due to the low diversity of the HETD

streams, the attributes of fish communities represented in this BRM IBI are not appropriate for assessing biotic integrity of HETD streams. Criteria for using this BRM IBI, based on river basin, elevation, number of native species, and trout population characteristics, are presented in Table 4. Fish samples not meeting these criteria should be assessed using alternative methods.

Figure 1. Level III Blue Ridge ecoregion (outlined in red) in Georgia. Major river basins include the Chattahoochee, Coosa, Savannah, and Tennessee

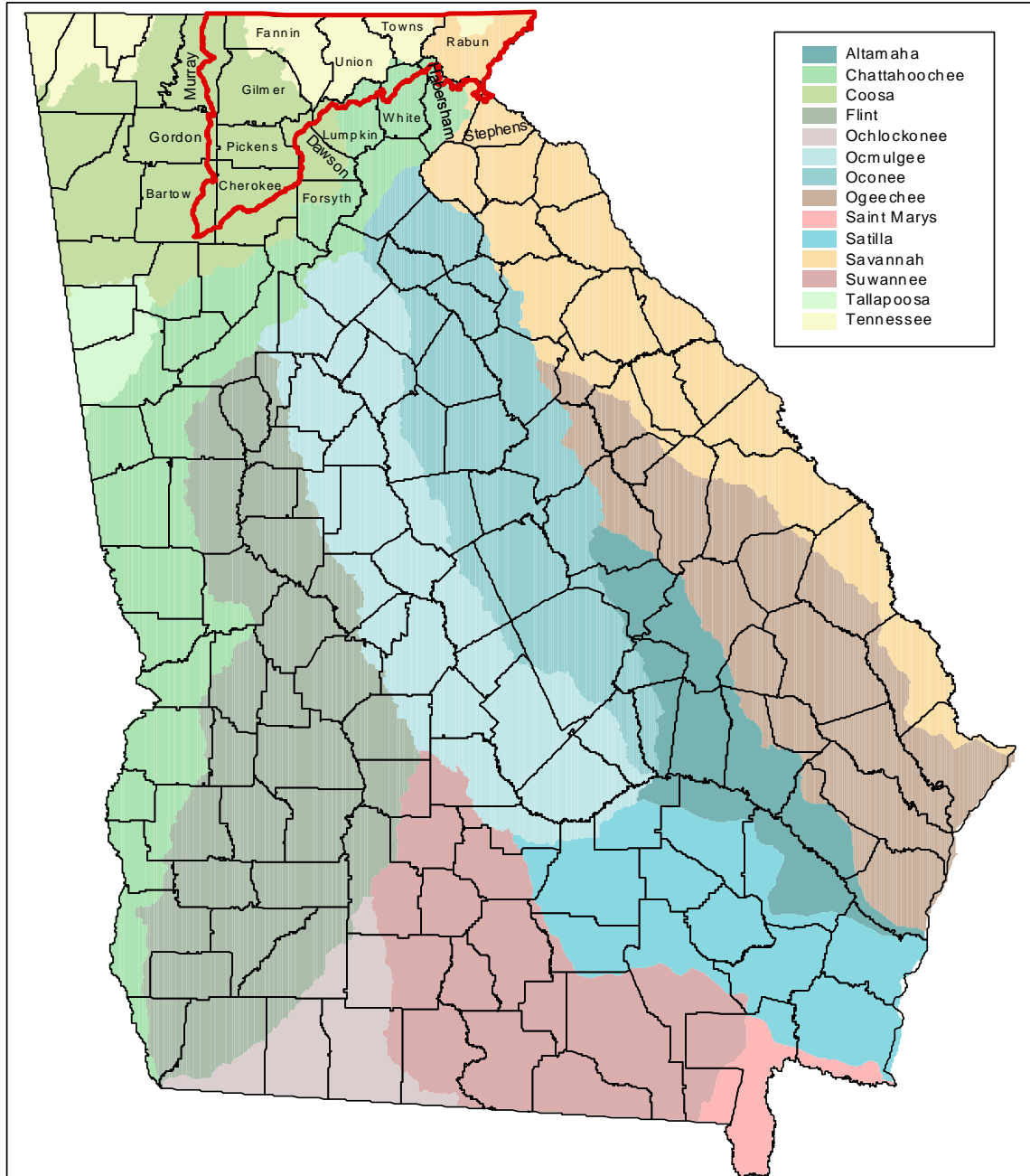


Table 1. State and federal rankings for fish found in the Coosa and Tennessee portions of the Blue Ridge ecoregion of Georgia (Georgia Department of Natural Resources Nongame Conservation Section, 2010).

Species	State	Federal	Basin
Blotched chub (<i>Erimystax insignis</i>)*	E		TEN
Blue shiner (<i>Cyprinella caerulea</i>)*	E	T	COO
Bridled darter (<i>Percina kusha</i>)*	E		COO
Burrhead shiner (<i>Notropis asperifrons</i>)*	T		COO
Cherokee darter (<i>Etheostoma scotti</i>)*	T	T	COO
Coosa chub (<i>Macrhybopsis</i> sp. Coosa chub)	E		COO
Dusky darter (<i>Percina sciera</i>)	R		TEN
Etowah darter (<i>Etheostoma etowahae</i>)*	E	E	COO
Fatlips minnow (<i>Phenacobius crassilabrum</i>)*	E		TEN
Goldline darter (<i>Percina aurolineata</i>)*	E	T	COO
Greenfin darter (<i>Etheostoma chlorbranchium</i>)*	T		TEN
Holiday darter (<i>Etheostoma brevirostrum</i>)*	E		COO
Lined chub (<i>Hybopsis lineapunctata</i>)*	R		COO
Olive darter (<i>Percina squamata</i>)	E		TEN
River redhorse (<i>Moxostoma carinatum</i>)*	R		COO/TEN
Rock darter (<i>Etheostoma rupestre</i>)	R		COO
Sicklefin redhorse (<i>Moxostoma</i> sp. sicklefin redhorse)	E	C	TEN
Silver shiner (<i>Notropis photogenis</i>)	E		TEN
Tangerine darter (<i>Percina aurantiaca</i>)	E		TEN
Trispot darter (<i>Etheostoma trisella</i>)*	E		COO
Wounded darter (<i>Etheostoma vulneratum</i>)	E		TEN

Status: E = endangered; R = rare; T = threatened; C = candidate

Basin: COO = Coosa; TEN = Tennessee

*Collected by GAWRD-SST

Table 2. Index of Biotic Integrity metrics for wadeable streams within the Coosa and Tennessee portions of the Blue Ridge ecoregion of Georgia, that are not high-elevation, trout-dominated (see Table 4). Scoring criteria include slopes of each trisection line (and coordinates where slope of trisection line becomes zero) for metrics 1 – 6 and numerical breaks for metrics 7 - 13.

Metric	Basin Group	Scoring Criteria	
<u>Species Richness Metrics</u>		<u>5/3 Breaks</u>	<u>3/1 Breaks</u>
1. Number of native species	COO	$y = 5.12x + 10.20$ (1.91, 20.00)	$y = 2.56x + 5.10$ (1.91, 10.00)
	TEN	$y = 3.94x + 7.78$ (1.72, 14.67)	$y = 1.97x + 3.89$ (1.72, 7.33)
2. Number of benthic fluvial specialist species	COO	$y = 1.38x + 2.75$ (2.35, 6.00)	$y = 0.69x + 1.38$ (2.35, 3.00)
	TEN	$y = 1.01x + 2.00$ (1.31, 3.33)	$y = 0.50x + 1.00$ (1.31, 1.67)
3. Number of native sunfish species ^a	COO	$y = 0.94x + 1.87$ (0.84, 2.67)	$y = 0.47x + 0.93$ (0.84, 1.33)
	TEN	$y = 0.64x + 1.27$ (2.17, 2.67)	$y = 0.32x + 0.63$ (2.17, 1.33)
Number of native centrarchid species ^b	COO	$y = 1.21x + 2.40$ (1.86, 4.67)	$y = 0.60x + 1.20$ (1.86, 2.33)
	TEN	$y = 0.87x + 1.72$ (1.82, 3.33)	$y = 0.44x + 0.86$ (1.82, 1.67)
4. Number of native insectivorous cyprinid species	COO	$y = 1.16x + 2.28$ (2.04, 4.67)	$y = 0.58x + 1.14$ (2.04, 2.33)
	TEN	$y = 1.21x + 2.40$ (2.39, 5.33)	$y = 0.61x + 1.20$ (2.39, 2.67)
5. Number of native round-bodied sucker species	COO	$y = 0.67x + 1.57$ (2.28, 3.33)	$y = 0.33x + 0.78$ (2.28, 1.67)
	TEN	$y = 0.60x + 1.20$ (2.43, 2.67)	$y = 0.30x + 0.60$ (2.43, 1.33)
6. Number of sensitive species ^a	COO	$y = 0.67x + 1.30$ (2.05, 2.67)	$y = 0.33x + 0.65$ (2.05, 1.33)
	TEN	$y = 0.87x + 1.73$ (1.84, 3.33)	$y = 0.43x + 0.87$ (2.05, 1.67)
Number of intolerant species ^b	COO	$y = 0.83x + 1.63$ (5.20, 6.00)	$y = 0.42x + 0.82$ (5.20, 3.00)
	TEN	$y = 1.00x + 2.00$ (1.33, 3.33)	$y = 0.50x + 1.00$ (1.33, 1.67)

Table 2 continued.

Metric	Basin Group	Scoring Criteria		
<u>Species Composition Metrics</u>		<u>5</u>	<u>3</u>	<u>1</u>
7. Evenness	COO	≥ 74.6	$\geq 65.3 - 74.6$	< 65.3
	TEN	≥ 70.5	$\geq 57.0 - 70.5$	< 57.0
8. % of individuals as <i>Lepomis</i> species	COO	≤ 11.4	$\leq 22.7 - 11.4$	> 22.7
	TEN	≤ 9.3	$\leq 18.5 - 9.3$	> 18.5
9. % of individuals as insectivorous cyprinids	COO	≥ 31.2	$\geq 15.6 - 31.2$	< 15.6
	TEN	≥ 29.4	$\geq 14.7 - 29.4$	< 14.7
10. % of individuals as generalist feeders and herbivores ^a	COO	≤ 38.1	$\leq 64.6 - 38.1$	> 64.6
	TEN	≤ 53.2	$\leq 71.9 - 53.2$	> 71.9
% of individuals as top carnivores ^b	COO	$\geq 4.8 - \leq 6.6$	$\geq 3.0 - 4.8$ $> 6.6 - \leq 8.4$	< 3.0 > 8.4
	TEN	$\geq 5.4 - \leq 7.8$	$\geq 3.1 - 5.4$ $> 7.8 - \leq 10.2$	< 3.1 > 10.2
11. % of individuals as benthic fluvial specialists	COO	≥ 54.0	$\geq 34.6 - 54.0$	< 34.6
	TEN	≥ 61.4	$\geq 39.8 - 61.4$	< 39.8
<u>Abundance and condition metrics</u>				
12. Number of individuals per 200 meters	COO	≥ 825.9	$\geq 487.8 - 825.9$	< 487.8
	TEN	≥ 737.1	$\geq 440.7 - 737.1$	< 440.7
13. % of individuals with external anomalies	COO	> 0.47 subtract 4 points from total score		
	TEN	> 0.71 subtract 4 points from total score		

^a used at sites with an upstream drainage basin area < 15 square miles

^b used at sites with an upstream drainage basin area ≥ 15 square miles

Table 3. Index of well-being (Iwb) scoring criteria and integrity classes for wadeable streams within the Coosa and Tennessee portions of the Blue Ridge ecoregion of Georgia that are not high-elevation, trout-dominated (see Table 4).

Score	DBA (mi ²)	Integrity Class	Attributes
≥ 8.3	< 15	Excellent	Comparable to the best regional conditions; all expected species for basin and ecoregion are present given the habitat and stream size; species, including the most intolerant, are present and represented by a full array of size classes; species diversity is high; number of individuals and total biomass are high and evenly distributed; each level of the food web is represented, indicating a balanced trophic structure.
≥ 9.1	≥ 15		
≥ 7.5 - 8.3	< 15	Good	Species richness somewhat below expectation; evenness scores decrease as species diversity falls, especially due to loss of the most intolerant species; high number of individuals in the sample, with several species of benthic fluvial specialists and insectivorous cyprinids present; some decrease in total biomass as trophic structure shows signs of stress.
≥ 8.8 - 9.1	≥ 15		
≥ 6.6 - 7.5	< 15	Fair	Species richness and diversity decline as several expected species are absent; number of individuals declines; total biomass continues to decline with some levels of the food web in low abundance or missing; trophic structure skewed toward generalist feeders and/or <i>Lepomis</i> species as the abundance of insectivorous cyprinid and benthic fluvial specialist species decreases.
≥ 8.0 - 8.8	≥ 15		
≥ 5.6 - 6.6	< 15	Poor	Number of individuals is low; species richness and diversity are very low, with benthic fluvial specialist and insectivorous cyprinid species in low abundance or absent; sample dominated by generalist feeders, herbivores, and <i>Lepomis</i> species; increase in the proportions of non-native species and hybrids; growth rates depressed as sample is heavily skewed to the smaller size classes; total biomass low.
≥ 7.7 - 8.0	≥ 15		
< 5.6	< 15	Very Poor	Sample represented by few individuals, mainly generalist feeders and <i>Lepomis</i> species; some sites dominated by non-native species; total biomass very low.
< 7.7	≥ 15		

Figure 2. Multidimensional scaling ordination plot of average Bray Curtis similarities for Coosa (COO) and Tennessee (TEN) basins. Sites are grouped by fish community similarities and averaged across basin and IBI class.

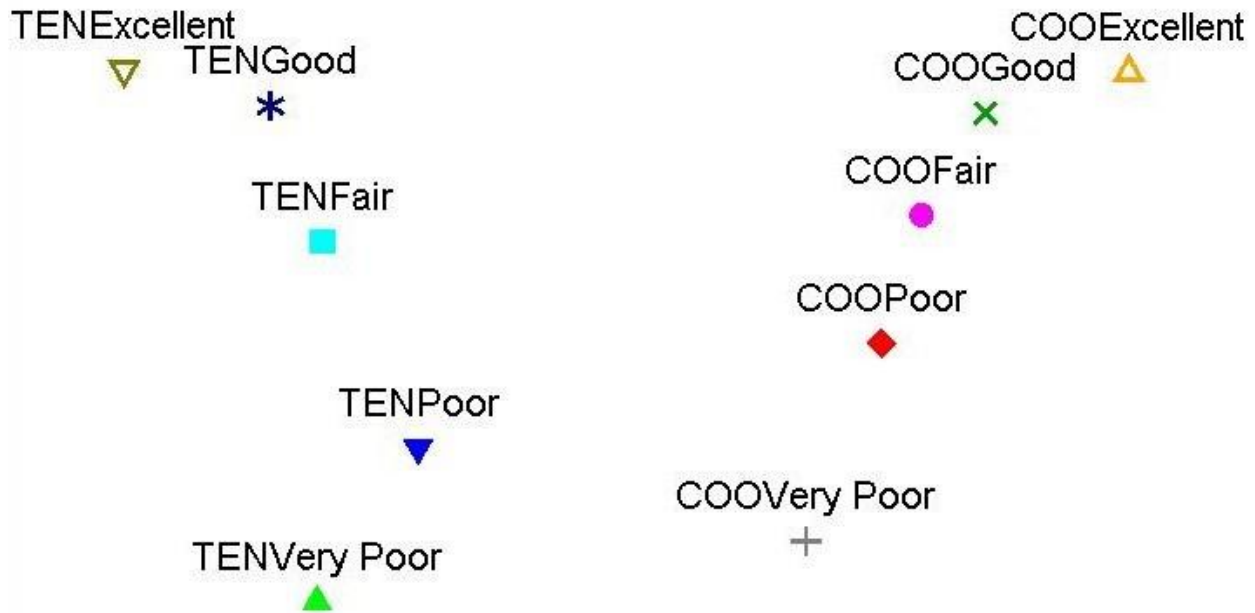


Table 4. Criteria for determining if streams in the Blue Ridge ecoregion (BRM) of Georgia should be scored using the index of biotic integrity (IBI) described in this document. **Sites meeting all of the components of criteria 1 OR criteria 2 should not be scored using the BRM IBI outlined in this document.**

Criteria	Elevation	DBA (mi ²)	Number Native Species	% Trout by Number
1	> 1400' (COO) > 1800' (TEN)	< 15	≤ 5	≥ 20%
2	≥ 50% Trout by Weight			

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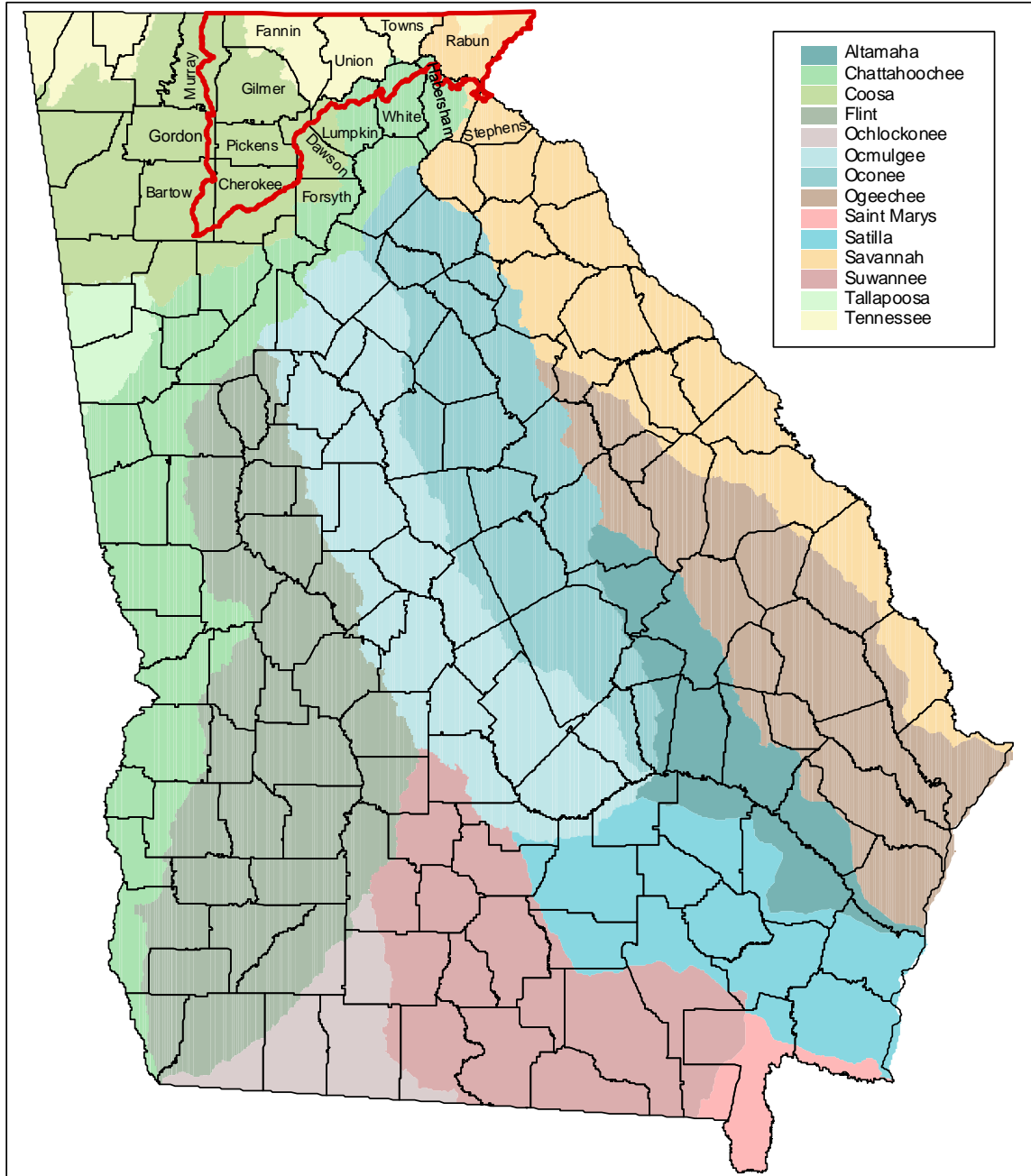


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Bridled darter (<i>Percina kusha</i>)*	E		COO
Burrhead shiner (<i>Notropis asperifrons</i>)*	T		COO
Cherokee darter (<i>Etheostoma scotti</i>)*	T	T	COO
Coosa chub (<i>Macrhybopsis</i> sp. Coosa chub)	E		COO
Dusky darter (<i>Percina sciera</i>)	R		TEN
Etowah darter (<i>Etheostoma etowahae</i>)*	E	E	COO
Fatlips minnow (<i>Phenacobius crassilabrum</i>)*	E		TEN
Goldline darter (<i>Percina aurolineata</i>)*	E	T	COO
Greenfin darter (<i>Etheostoma chlorobranchium</i>)*	T		TEN
Holiday darter (<i>Etheostoma brevirostrum</i>)*	E		COO
Lined chub (<i>Hybopsis lineapunctata</i>)*	R		COO
Olive darter (<i>Percina squamata</i>)	E		TEN
River redhorse (<i>Moxostoma carinatum</i>)*	R		COO/TEN
Rock darter (<i>Etheostoma rupestre</i>)	R		COO
Sicklefin redhorse (<i>Moxostoma</i> sp. sicklefin redhorse)	E	C	TEN
Silver shiner (<i>Notropis photogenis</i>)	E		TEN
Tangerine darter (<i>Percina aurantiaca</i>)	E		TEN
Trispot darter (<i>Etheostoma trisella</i>)*	E		COO
Wounded darter (<i>Etheostoma vulneratum</i>)	E		TEN

Status: E = endangered; R = rare; T = threatened; C = candidate

Basin: COO = Coosa; TEN = Tennessee

*Collected by GAWRD-SST

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1. Number of native species	COO	$y = 5.12x + 10.20$ (1.91, 20.00)	$y = 2.56x + 5.10$ (1.91, 10.00)
	TEN	$y = 3.94x + 7.78$ (1.72, 14.67)	$y = 1.97x + 3.89$ (1.72, 7.33)
2. Number of benthic fluvial specialist species	COO	$y = 1.38x + 2.75$ (2.35, 6.00)	$y = 0.69x + 1.38$ (2.35, 3.00)
	TEN	$y = 1.01x + 2.00$ (1.31, 3.33)	$y = 0.50x + 1.00$ (1.31, 1.67)
3. Number of native sunfish species ^a	COO	$y = 0.94x + 1.87$ (0.84, 2.67)	$y = 0.47x + 0.93$ (0.84, 1.33)
	TEN	$y = 0.64x + 1.27$ (2.17, 2.67)	$y = 0.32x + 0.63$ (2.17, 1.33)
Number of native centrarchid species ^b	COO	$y = 1.21x + 2.40$ (1.86, 4.67)	$y = 0.60x + 1.20$ (1.86, 2.33)
	TEN	$y = 0.87x + 1.72$ (1.82, 3.33)	$y = 0.44x + 0.86$ (1.82, 1.67)
4. Number of native insectivorous cyprinid species	COO	$y = 1.16x + 2.28$ (2.04, 4.67)	$y = 0.58x + 1.14$ (2.04, 2.33)
	TEN	$y = 1.21x + 2.40$ (2.39, 5.33)	$y = 0.61x + 1.20$ (2.39, 2.67)
5. Number of native round-bodied sucker species	COO	$y = 0.67x + 1.57$ (2.28, 3.33)	$y = 0.33x + 0.78$ (2.28, 1.67)
	TEN	$y = 0.60x + 1.20$ (2.43, 2.67)	$y = 0.30x + 0.60$ (2.43, 1.33)
6. Number of sensitive species ^a	COO	$y = 0.67x + 1.30$ (2.05, 2.67)	$y = 0.33x + 0.65$ (2.05, 1.33)
	TEN	$y = 0.87x + 1.73$ (1.84, 3.33)	$y = 0.43x + 0.87$ (2.05, 1.67)
Number of intolerant species ^b	COO	$y = 0.83x + 1.63$ (5.20, 6.00)	$y = 0.42x + 0.82$ (5.20, 3.00)
	TEN	$y = 1.00x + 2.00$ (1.33, 3.33)	$y = 0.50x + 1.00$ (1.33, 1.67)

Table 2 continued.

Metric	Basin Group	Scoring Criteria		
<u>Species Composition Metrics</u>		<u>5</u>	<u>3</u>	<u>1</u>
7. Evenness	COO	≥ 74.6	$\geq 65.3 - 74.6$	< 65.3
	TEN	≥ 70.5	$\geq 57.0 - 70.5$	< 57.0
8. % of individuals as <i>Lepomis</i> species	COO	≤ 11.4	$\leq 22.7 - 11.4$	> 22.7
	TEN	≤ 9.3	$\leq 18.5 - 9.3$	> 18.5
9. % of individuals as insectivorous cyprinids	COO	≥ 31.2	$\geq 15.6 - 31.2$	< 15.6
	TEN	≥ 29.4	$\geq 14.7 - 29.4$	< 14.7
10. % of individuals as generalist feeders and herbivores ^a	COO	≤ 38.1	$\leq 64.6 - 38.1$	> 64.6
	TEN	≤ 53.2	$\leq 71.9 - 53.2$	> 71.9
% of individuals as top carnivores ^b	COO	$\geq 4.8 - \leq 6.6$	$\geq 3.0 - 4.8$ $> 6.6 - \leq 8.4$	< 3.0 > 8.4
	TEN	$\geq 5.4 - \leq 7.8$	$\geq 3.1 - 5.4$ $> 7.8 - \leq 10.2$	< 3.1 > 10.2
11. % of individuals as benthic fluvial specialists	COO	≥ 54.0	$\geq 34.6 - 54.0$	< 34.6
	TEN	≥ 61.4	$\geq 39.8 - 61.4$	< 39.8
<u>Abundance and condition metrics</u>				
12. Number of individuals per 200 meters	COO	≥ 825.9	$\geq 487.8 - 825.9$	< 487.8
	TEN	≥ 737.1	$\geq 440.7 - 737.1$	< 440.7
13. % of individuals with external anomalies	COO	> 47 subtract 4 points from total score		
	TEN	> 71 subtract 4 points from total score		

^a used at sites with an upstream drainage basin area < 15 square miles

^b used at sites with an upstream drainage basin area ≥ 15 square miles

Table 3. Index of well-being (Iwb) scoring criteria and integrity classes for wadeable streams within the Coosa and Tennessee portions of the Blue Ridge ecoregion of Georgia that are not high-elevation, trout-dominated (see Table 4).

Score	DBA (mi ²)	Integrity Class	Attributes
≥ 8.3	< 15	Excellent	Comparable to the best regional conditions; all expected species for basin and ecoregion are present given the habitat and stream size; species, including the most intolerant, are present and represented by a full array of size classes; species diversity is high; number of individuals and total biomass are high and evenly distributed; each level of the food web is represented, indicating a balanced trophic structure.
≥ 9.1	≥ 15		
≥ 7.5 - 8.3	< 15	Good	Species richness somewhat below expectation; evenness scores decrease as species diversity falls, especially due to loss of the most intolerant species; high number of individuals in the sample, with several species of benthic fluvial specialists and insectivorous cyprinids present; some decrease in total biomass as trophic structure shows signs of stress.
≥ 8.8 - 9.1	≥ 15		
≥ 6.6 - 7.5	< 15	Fair	Species richness and diversity decline as several expected species are absent; number of individuals declines; total biomass continues to decline with some levels of the food web in low abundance or missing; trophic structure skewed toward generalist feeders and/or <i>Lepomis</i> species as the abundance of insectivorous cyprinid and benthic fluvial specialist species decreases.
≥ 8.0 - 8.8	≥ 15		
≥ 5.6 - 6.6	< 15	Poor	Number of individuals is low; species richness and diversity are very low, with benthic fluvial specialist and insectivorous cyprinid species in low abundance or absent; sample dominated by generalist feeders, herbivores, and <i>Lepomis</i> species; increase in the proportions of non-native species and hybrids; growth rates depressed as sample is heavily skewed to the smaller size classes; total biomass low.
≥ 7.7 - 8.0	≥ 15		
< 5.6	< 15	Very Poor	Sample represented by few individuals, mainly generalist feeders and <i>Lepomis</i> species; some sites dominated by non-native species; total biomass very low.
< 7.7	≥ 15		

Figure 2. Multidimensional scaling ordination plot of average Bray Curtis similarities for Coosa (COO) and Tennessee (TEN) basins. Sites are grouped by fish community similarities and averaged across basin and IBI class.

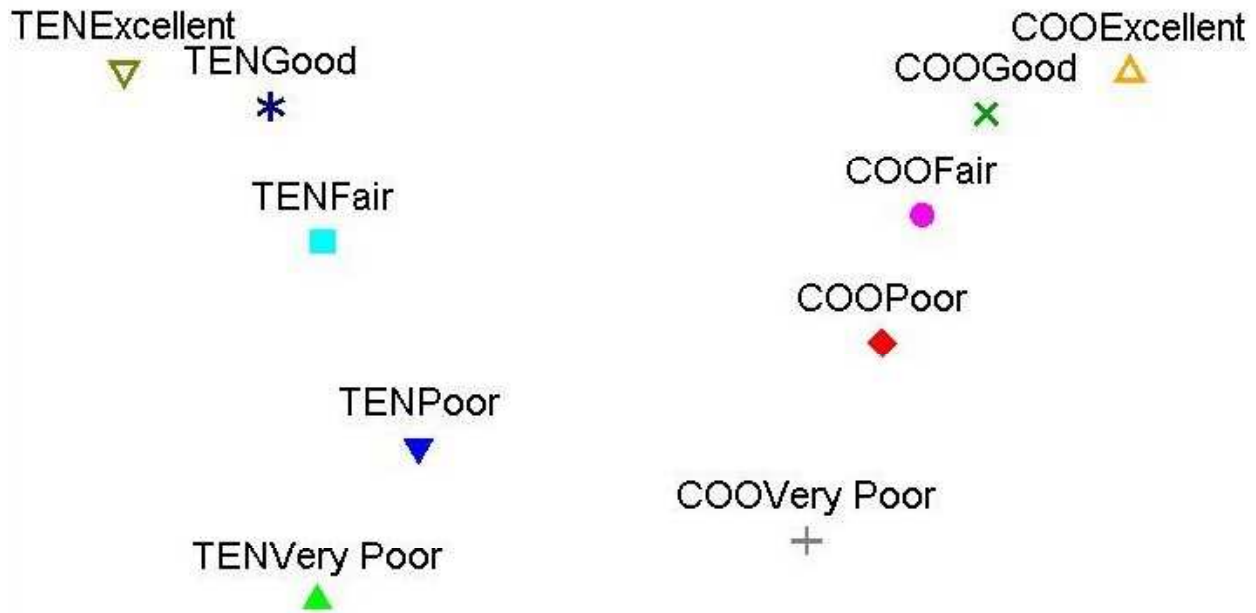


Table 4. Criteria for determining if streams in the Blue Ridge ecoregion (BRM) of Georgia should be scored using the index of biotic integrity (IBI) described in this document. **Sites meeting all of the components of criteria 1 OR criteria 2 should not be scored using the BRM IBI outlined in this document.**

Criteria	Elevation	DBA (mi ²)	Number Native Species	% Trout by Number
1	> 1400' (COO) > 1800' (TEN)	< 15	≤ 5	≥ 20%
2	≥ 50% Trout by Weight			

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Appendix A

Coosa and Tennessee Blue Ridge Ecoregion Fish List Including Tolerance Rankings, Feeding Guilds, Species Categories, and Federal and State Rankings

Fishes of the Coosa and Tennessee River Basins within the Blue Ridge Ecoregion of Georgia.

Species	Tolerance Ranking	Feeding Guild	Species Category	Drainage Basin	Federal Status	State Satus
Petromyzontidae						
Chestnut Lamprey* <i>Ichthyomyzon castaneus</i>		PR		COO, TEN		
Southern Brook Lamprey* <i>Ichthyomyzon gagei</i>		HB		COO		
Mountain Brook Lamprey* <i>Ichthyomyzon greeleyi</i>	INT	HB		TEN		
Least Brook Lamprey <i>Lampetra aepyptera</i>	INT	HB		COO		
Lepisosteidae						
Longnose Gar <i>Lepisosteus osseus</i>		CR		COO, TEN		
Clupeidae						
Gizzard Shad <i>Dorosoma cepedianum*</i>		OM		COO, TEN		
Threadfin Shad <i>Dorosoma petenense</i>		OM		COO, TEN		
Cyprinidae						
Central Stoneroller* <i>Campostoma anomalum</i>		HB		TEN		
Largescale Stoneroller* <i>Campostoma oligolepis</i>		HB		COO, TEN		
Rosyside Dace* <i>Clinostomus funduloides</i>		IN		TEN		
Blue Shiner* <i>Cyprinella caerulea</i>	INT	IN	BFS	COO	T	E
Alabama Shiner* <i>Cyprinella callistia</i>		IN	BFS	COO		
Whitetail Shiner* <i>Cyprinella galactura</i>		IN	BFS	TEN		
Tricolor Shiner* <i>Cyprinella trichroistia</i>		IN		COO		
Blacktail shiner* <i>Cyprinella venusta</i>		IN		COO		
Common Carp* <i>Cyprinus carpio</i>		GE		EXOTIC		
Blotched Chub* <i>Erimystax insignis</i>		OM	BFS	TEN		E

Species	Tolerance Ranking	Feeding Guild	Species Category	Drainage Basin	Federal Status	State Satus
Bigeye Chub* <i>Hybopsis amblops</i>		IN	BFS	TEN		
Lined Chub* <i>Hybopsis lineapunctata</i>	INT	IN	BFS	COO		R
Striped Shiner* <i>Luxilus chrysocephalus</i>		IN		COO, TEN		
Warpaint Shiner* <i>Luxilus coccogenis</i>		IN		TEN		
Bandfin Shiner* <i>Luxilus zonistius</i>		IN		COO**		
Mountain Shiner* <i>Lythrurus lirus</i>	INT	IN		COO		
Coosa Chub <i>Macrhybopsis</i> sp. Coosa Chub	INT	IN	BFS	COO		E
Bluehead Chub* <i>Nocomis leptcephalus</i>		OM		COO, TEN**		
River Chub* <i>Nocomis micropogon</i>		OM		COO**, TEN		
Golden Shiner* <i>Notemigonus crysoleucas</i>		GE		COO, TEN		
Burrhead Shiner* <i>Notropis asperifrons</i>	INT	IN		COO		T
Rainbow Shiner* <i>Notropis chrosomus</i>	HWI	IN		COO		
Tennessee Shiner* <i>Notropis leuciodus</i>		IN		TEN		
Longnose Shiner <i>Notropis longirostris</i>		IN	BFS	COO		
Yellowfin Shiner* <i>Notropis lutipinnis</i>		IN		COO, TEN		
Silver Shiner <i>Notropis photogenis</i>		IN		TEN		E
Mirror Shiner* <i>Notropis spectrunculus</i>		IN	BFS	TEN		
Silverstripe Shiner* <i>Notropis stilbius</i>		IN		COO		
Telescope Shiner <i>Notropis telescopus</i>		IN		TEN		
Coosa Shiner* <i>Notropis xaenocephalus</i>		IN		COO		

Species	Tolerance Ranking	Feeding Guild	Species Category	Drainage Basin	Federal Status	State Status
Rifle Minnow* <i>Phenacobius catostomus</i>	INT	IN	BFS	COO		
Fatlips Minnow* <i>Phenacobius crassilabrum</i>	INT	IN	BFS	TEN		E
Bullhead Minnow <i>Pimephales vigilax</i>		OM		COO		
Blacknose Dace* <i>Rhinichthys atratulus</i>		IN	BFS	COO, TEN		
Longnose Dace* <i>Rhinichthys cataractae</i>	HWI	IN	BFS	TEN		
Creek Chub* <i>Semotilus atromaculatus</i>		GE		COO, TEN		
Catostomidae						
White Sucker* <i>Catostomus commersoni</i>		IN	BFS	TEN		
Alabama Hogsucker* <i>Hypentelium etowanum</i>		IN	BFS	COO		
Northern Hogsucker* <i>Hypentelium nigricans</i>		IN	BFS	COO, TEN		
Spotted Sucker* <i>Minytrema melanops</i>		IN	BFS	COO, TEN		
Silver Redhorse <i>Moxostoma anisurum</i>		IN	BFS	TEN		
River Redhorse* <i>Moxostoma carinatum</i>	INT	IN	BFS	COO, TEN		R
Black Redhorse* <i>Moxostoma duquesnei</i>	INT	IN	BFS	COO, TEN		
Golden Redhorse* <i>Moxostoma erythrurum</i>		IN	BFS	COO, TEN		
Blacktail Redhorse* <i>Moxostoma poecilurum</i>		IN	BFS	COO		
Sicklefin Redhorse <i>Moxostoma</i> sp. sicklefin redhorse	INT	IN	BFS	TEN	C	E
Ictaluridae						
Snail Bullhead* <i>Ameiurus brunneus</i>		GE		COO, TEN**		
Black Bullhead* <i>Ameiurus melas</i>		GE		COO, TEN		
Yellow Bullhead* <i>Ameiurus natalis</i>		GE		COO, TEN		

Species	Tolerance Ranking	Feeding Guild	Species Category	Drainage Basin	Federal Status	State Status
Brown Bullhead* <i>Ameiurus nebulosus</i>		GE		COO, TEN		
Flat Bullhead* <i>Ameiurus platycephalus</i>		GE		TEN**		
Channel Catfish* <i>Ictalurus punctatus</i>		GE		COO, TEN		
Speckled Madtom* <i>Noturus leptacanthus</i>		BI	BFS	COO		
Flathead Catfish <i>Pylodictis olivaris</i>		CR		COO, TEN		
			Salmonidae			
Rainbow Trout* <i>Oncorhynchus mykiss</i>		CR		EXOTIC		
Brown Trout* <i>Salmo trutta</i>		CR		EXOTIC		
Brook Trout* <i>Salvelinus fontinalis</i>	INT	CR		COO**, TEN		
			Fundulidae			
Southern Studfish* <i>Fundulus stellifer</i>		IN		COO		
			Poeciliidae			
Mosquitofish* <i>Gambusia sp.</i>		GE		COO, TEN		
			Cottidae			
Mottled Sculpin* <i>Cottus bairdi</i>		GE	BFS	COO, TEN		
Banded Sculpin* <i>Cottus carolinae</i>		GE	BFS	COO, TEN		
			Percichthyidae			
White Bass <i>Morone chrysops</i>		CR		COO**, TEN		
Striped Bass <i>Morone saxatilis</i>		CR		COO		
			Centrarchidae			
Shadow Bass* <i>Ambloplites ariommus</i>	INT	CR	SF	COO		
Rock Bass* <i>Ambloplites rupestris</i>	INT	CR	SF	TEN		
Redbreast Sunfish* <i>Lepomis auritus</i>		IN	SF	COO**, TEN**		
Green Sunfish* <i>Lepomis cyanellus</i>		GE	SF	COO, TEN		

Species	Tolerance Ranking	Feeding Guild	Species Category	Drainage Basin	Federal Status	State Status
Warmouth* <i>Lepomis gulosus</i>		CR	SF	COO, TEN		
Bluegill* <i>Lepomis macrochirus</i>		IN	SF	COO, TEN		
Longear Sunfish* <i>Lepomis megalotis</i>		IN	SF	COO, TEN		
Redear Sunfish* <i>Lepomis microlophus</i>		IN	SF	COO, TEN		
Spotted Sunfish* <i>Lepomis punctatus x miniatus</i>		IN	SF	COO		
Redeye Bass* <i>Micropterus coosae</i>		CR		COO, TEN**		
Smallmouth Bass* <i>Micropterus dolomieu</i>		CR		TEN		
Spotted Bass* <i>Micropterus punctulatus</i>		CR		COO, TEN		
Largemouth bass* <i>Micropterus salmoides</i>		CR		COO, TEN		
White crappie <i>Pomoxis annularis</i>		CR		COO, TEN		
Black crappie <i>Pomoxis nigromaculatus</i>		CR		COO, TEN		
			Percidae			
Greenside darter* <i>Etheostoma blennioides</i>		IN	BFS	TEN		
Holiday darter* <i>Etheostoma brevirostrum</i>	INT	IN	BFS	COO		E
Greenfin darter* <i>Etheostoma chlorobranchium</i>		IN	BFS	TEN		T
Coosa darter* <i>Etheostoma coosae</i>		IN	BFS	COO		
Etowah darter* <i>Etheostoma etowahae</i>	INT	IN	BFS	COO	E	E
Greenbreast darter* <i>Etheostoma jordani</i>	INT	IN	BFS	COO		
Redline darter* <i>Etheostoma rufilineatum</i>		IN	BFS	TEN		
Rock darter <i>Etheostoma rupestre</i>		IN	BFS	COO		R

Species	Tolerance Ranking	Feeding Guild	Species Category	Drainage Basin	Federal Status	State Status
Cherokee darter* <i>Etheostoma scotti</i>		IN	BFS	COO	T	T
Speckled darter* <i>Etheostoma stigmaeum</i>		IN	BFS	COO		
Trispot darter* <i>Etheostoma trisella</i>	INT	IN	BFS	COO		E
Wounded darter <i>Etheostoma vulneratum</i>	INT	IN	BFS	TEN		E
Banded darter* <i>Etheostoma zonale</i>		IN	BFS	TEN		
Yellow perch* <i>Perca flavescens</i>		CR		EXOTIC		
Tangerine darter <i>Percina aurantiaca</i>		IN	BFS	TEN		E
Goldline darter* <i>Percina aurolineata</i>	INT	IN	BFS	COO	T	E
Gilt darter* <i>Percina evides</i>	INT	IN	BFS	TEN		
Mobile logperch* <i>Percina kathae</i>		IN	BFS	COO		
Blackbanded darter* <i>Percina nigrofasciata</i>		BI	BFS	COO		
Bronze darter* <i>Percina palmaris</i>		BI	BFS	COO		
Dusky darter <i>Percina sciera</i>		BI	BFS	TEN		R
Olive darter <i>Percina squamata</i>	INT	BI	BFS	TEN		R
Bridled darter* <i>Percina kusha</i>	INT	BI	BFS	COO		E

*Collected by GAWRD Stream Survey Team

Pollution Tolerance: **HWI** = headwater intolerant; **INT** = intolerant

Feeding Guild: **CR** = carnivore; **GE** = generalist; **HB** = herbivore; **OM** = omnivore; **IN** = invertivore;

BI = benthic invertivore; **PR** = parasitic

Species Category: **BFS** = benthic fluvial specialist; **SF** = sunfish species;

Drainage Basin: **COO** = Coosa; **TEN** = Tennessee; **EXOTIC** = introduced to Georgia;

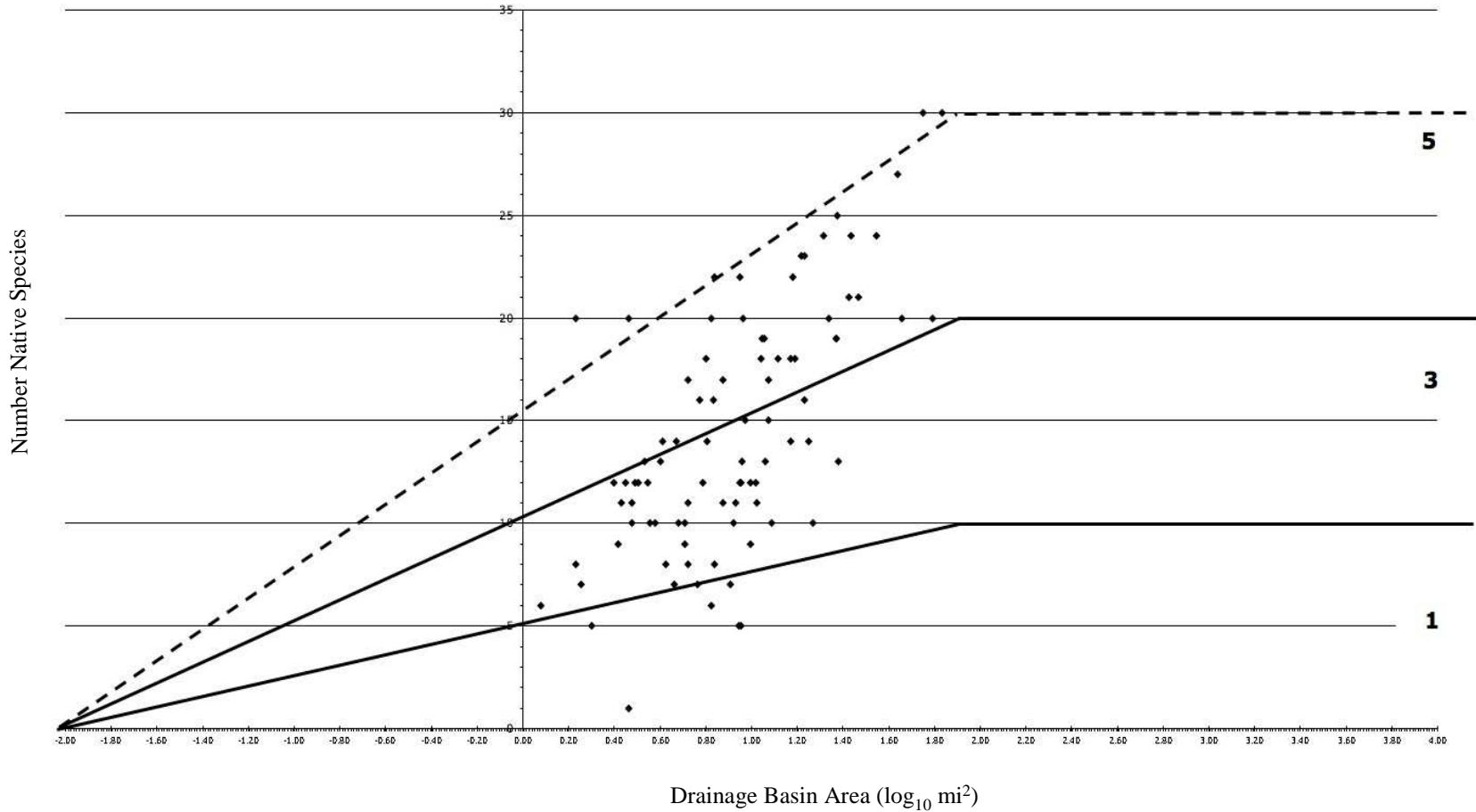
** introduced to basin

Status: **E** = endangered; **T** = threatened; **R** = rare; **C** = of concern

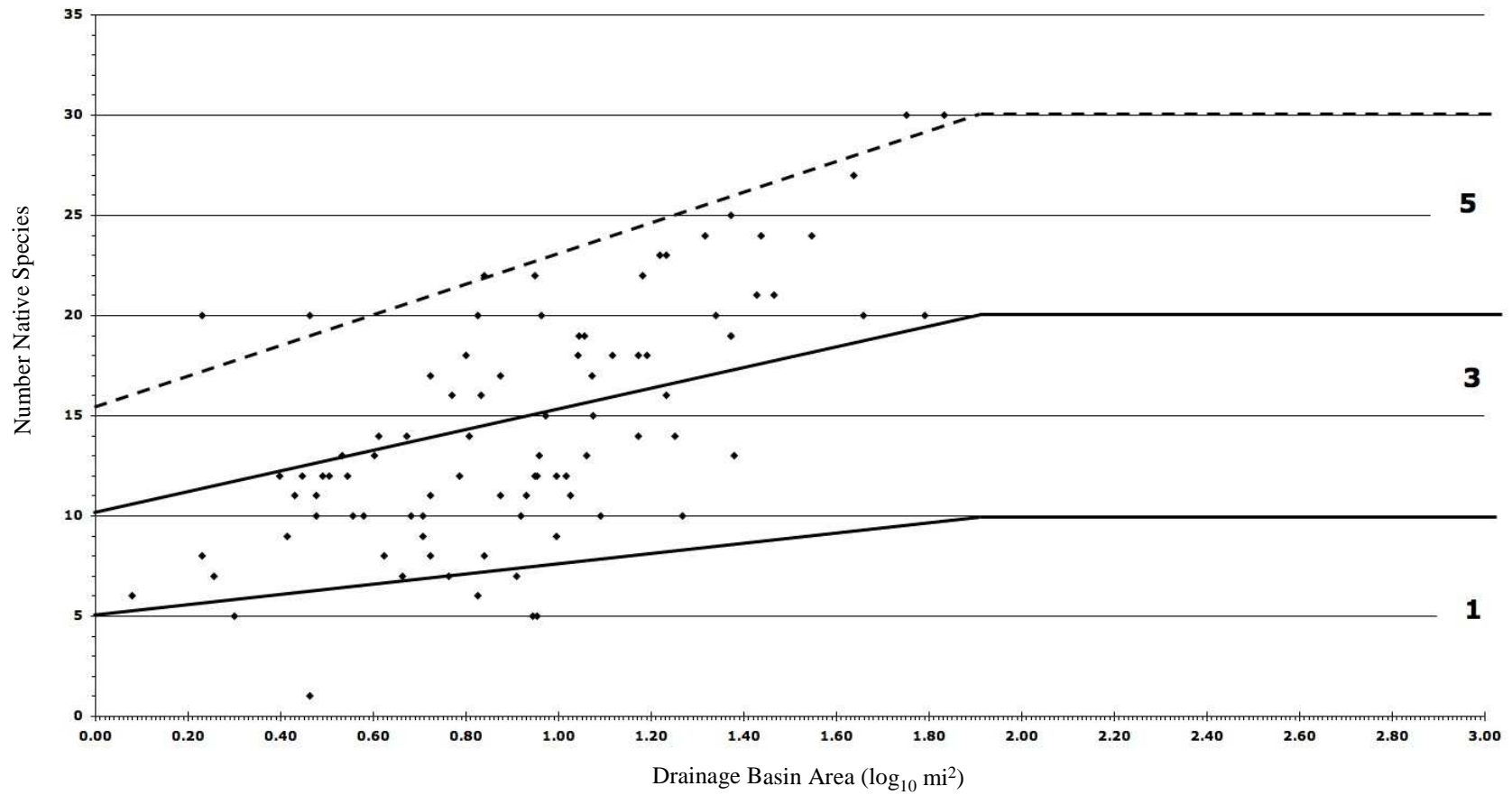
Appendix B

Blue Ridge Ecoregion Maximum Species Richness Graphs, Metrics 1 - 6,
for the Coosa and Tennessee Basins

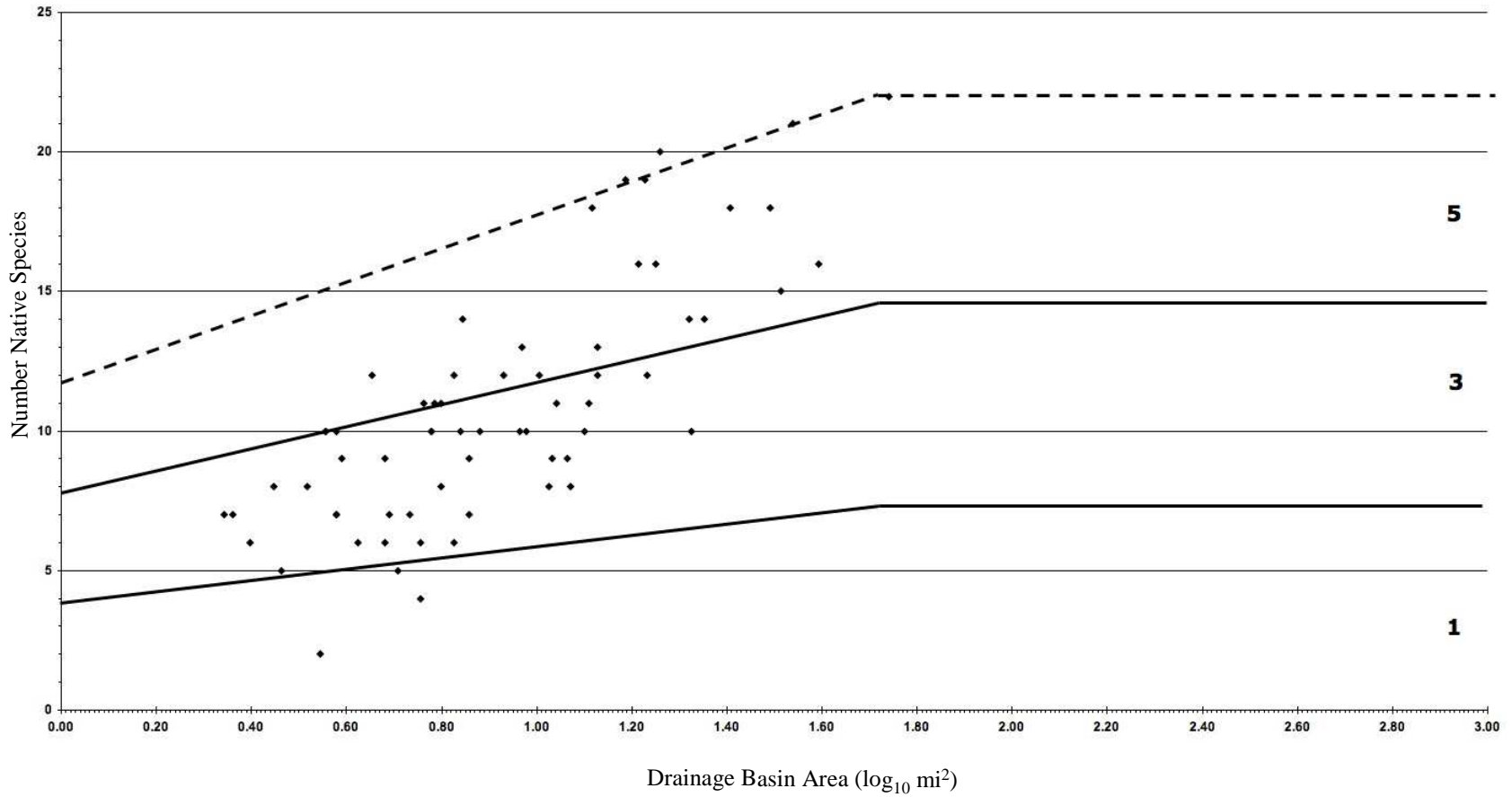
EXAMPLE. Maximum species richness graph. Maximum species richness (denoted by dashed line) drawn by eye, and the area below trisected to determine the cutoffs for scoring breaks (Lyons 1992). Sites falling on the line are scored up. Actual graphs are truncated at the y-axis, as sites with drainage basin areas $< 1 \text{ mi}^2$ are not to be scored using these criteria .



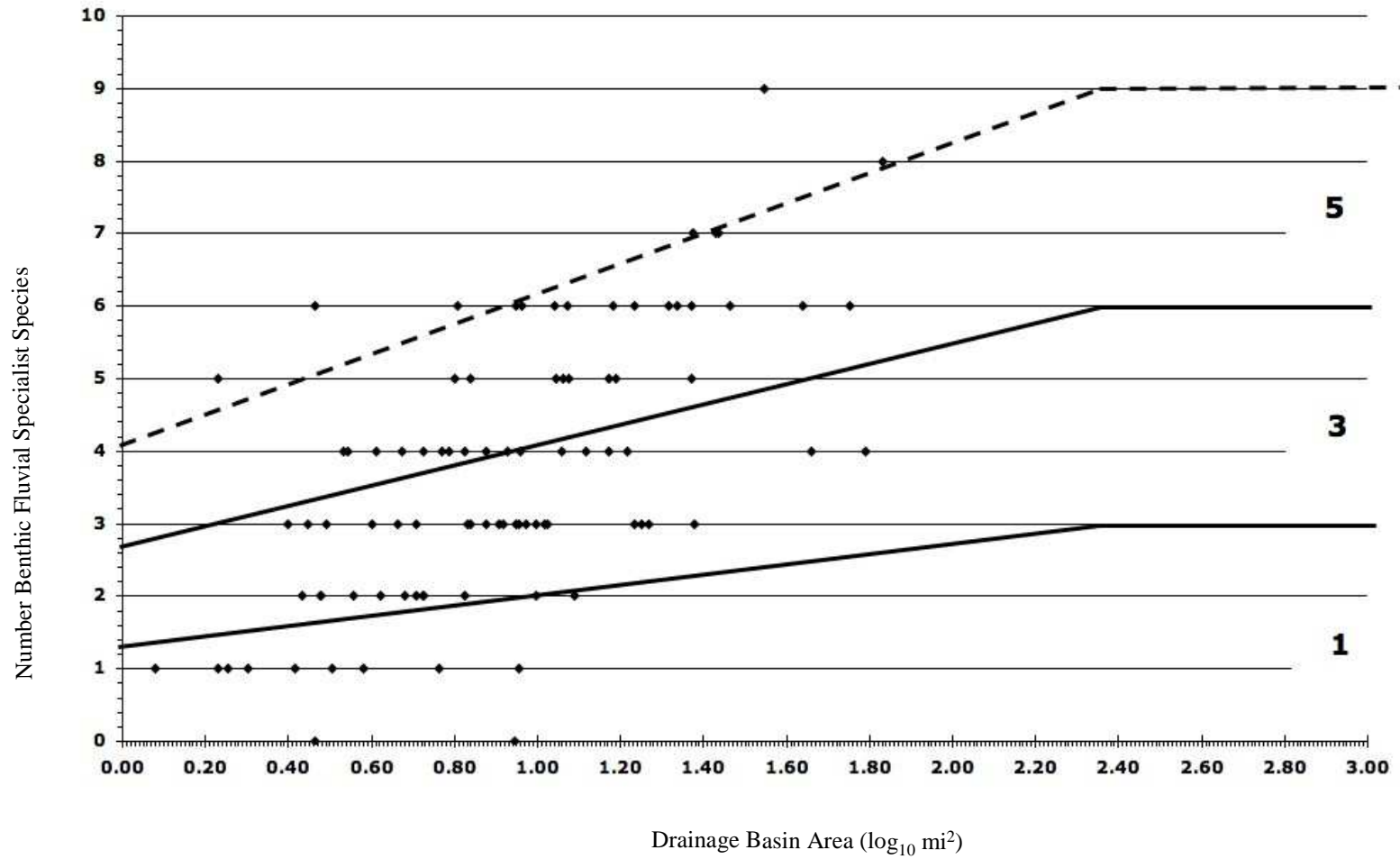
Metric 1 Coosa. Total number of native species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



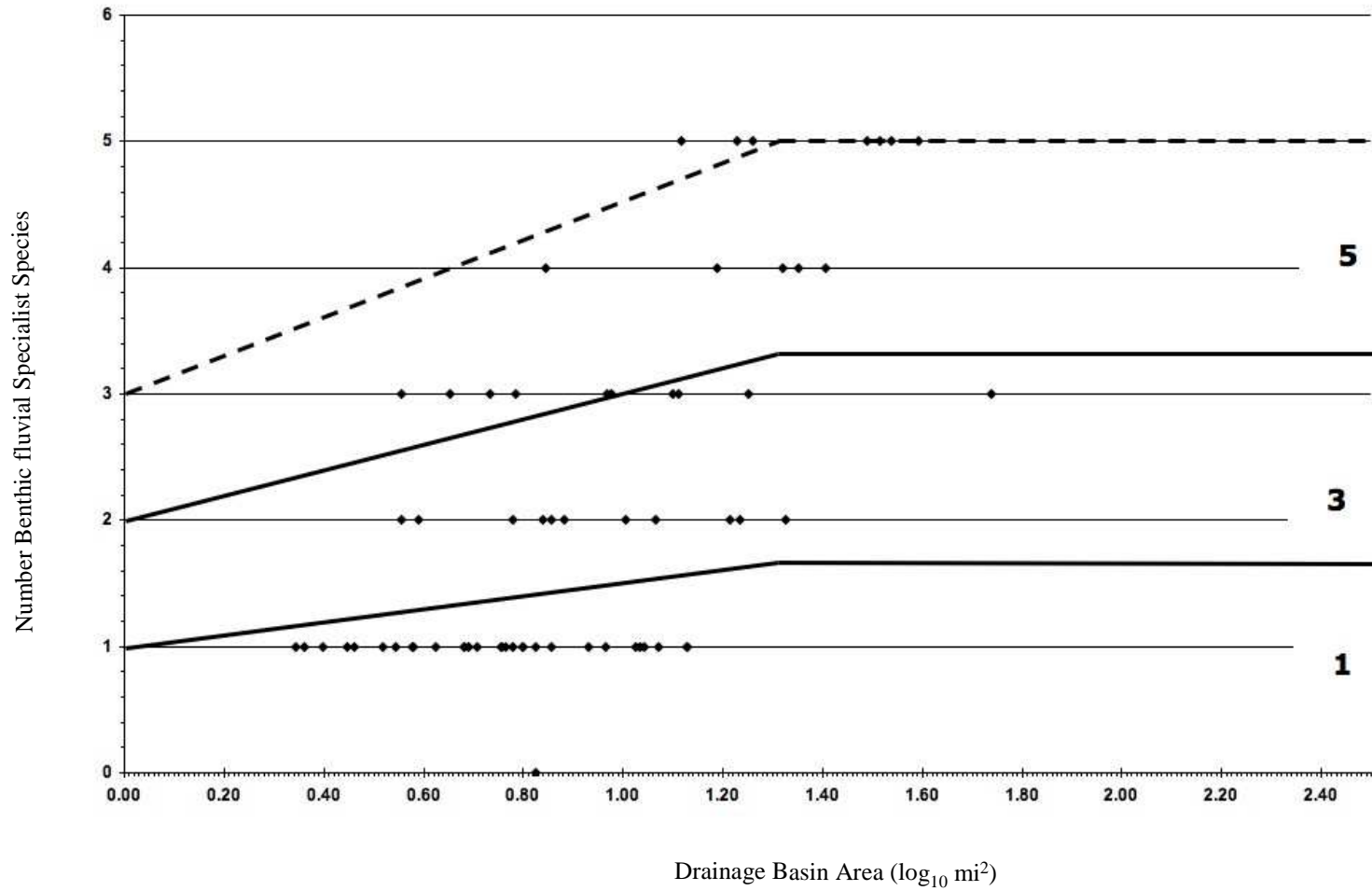
Metric 1 Tennessee. Total number of native species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



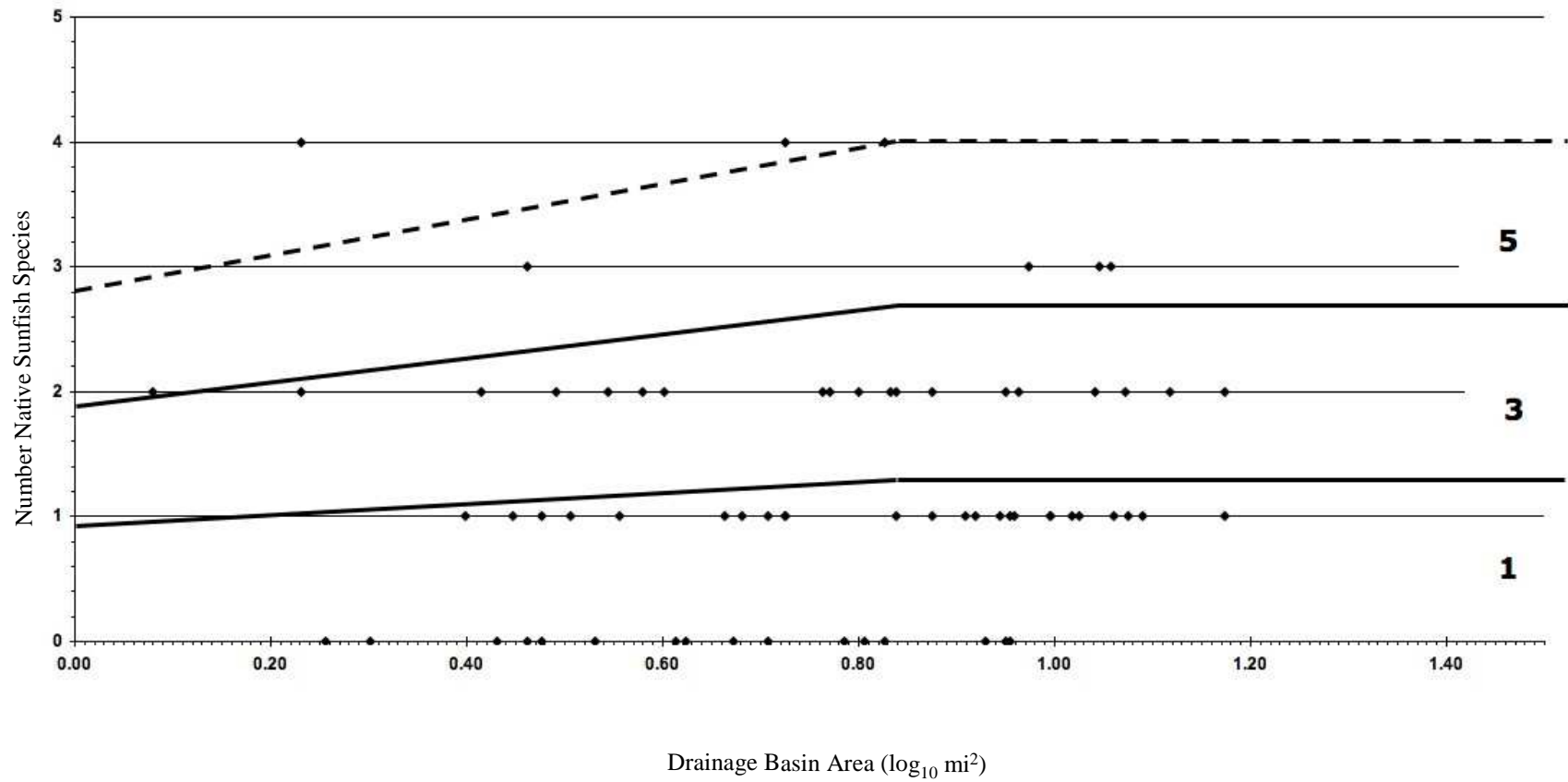
Metric 2 Coosa. Total number of benthic fluvial specialist species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



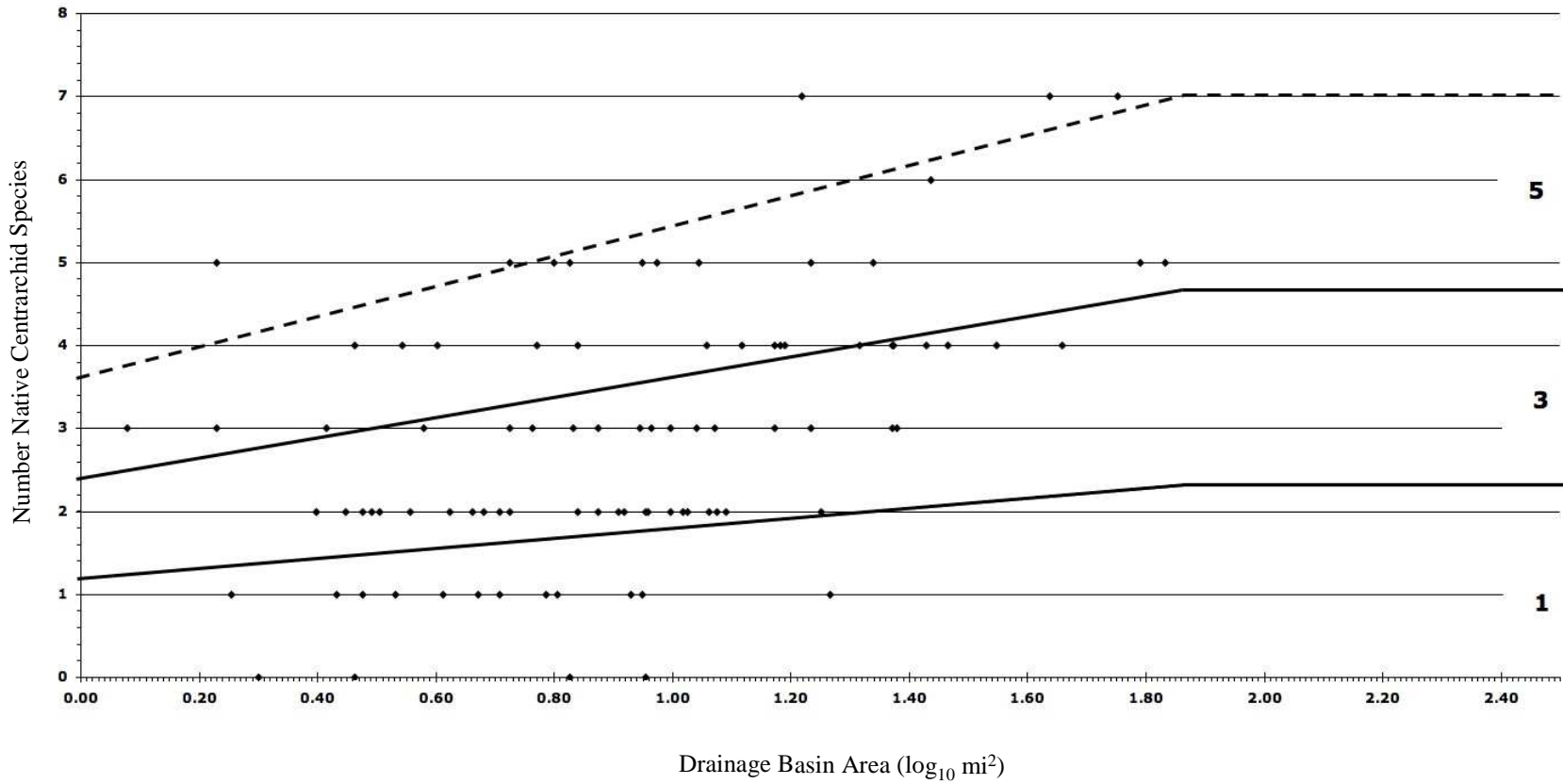
Metric 2 Tennessee. Total number of benthic fluvial specialist species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



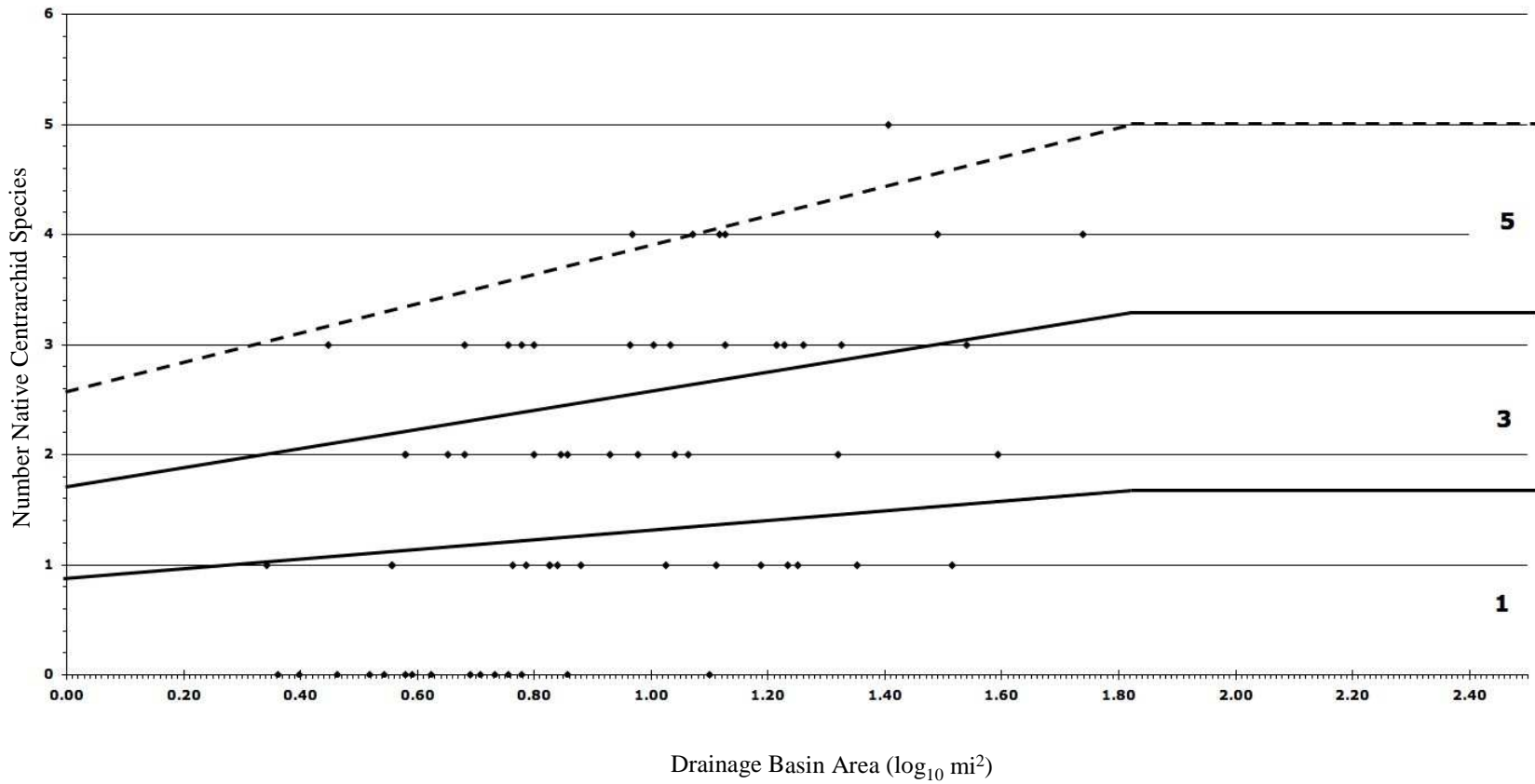
Metric 3a Coosa. Total number of native sunfish species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



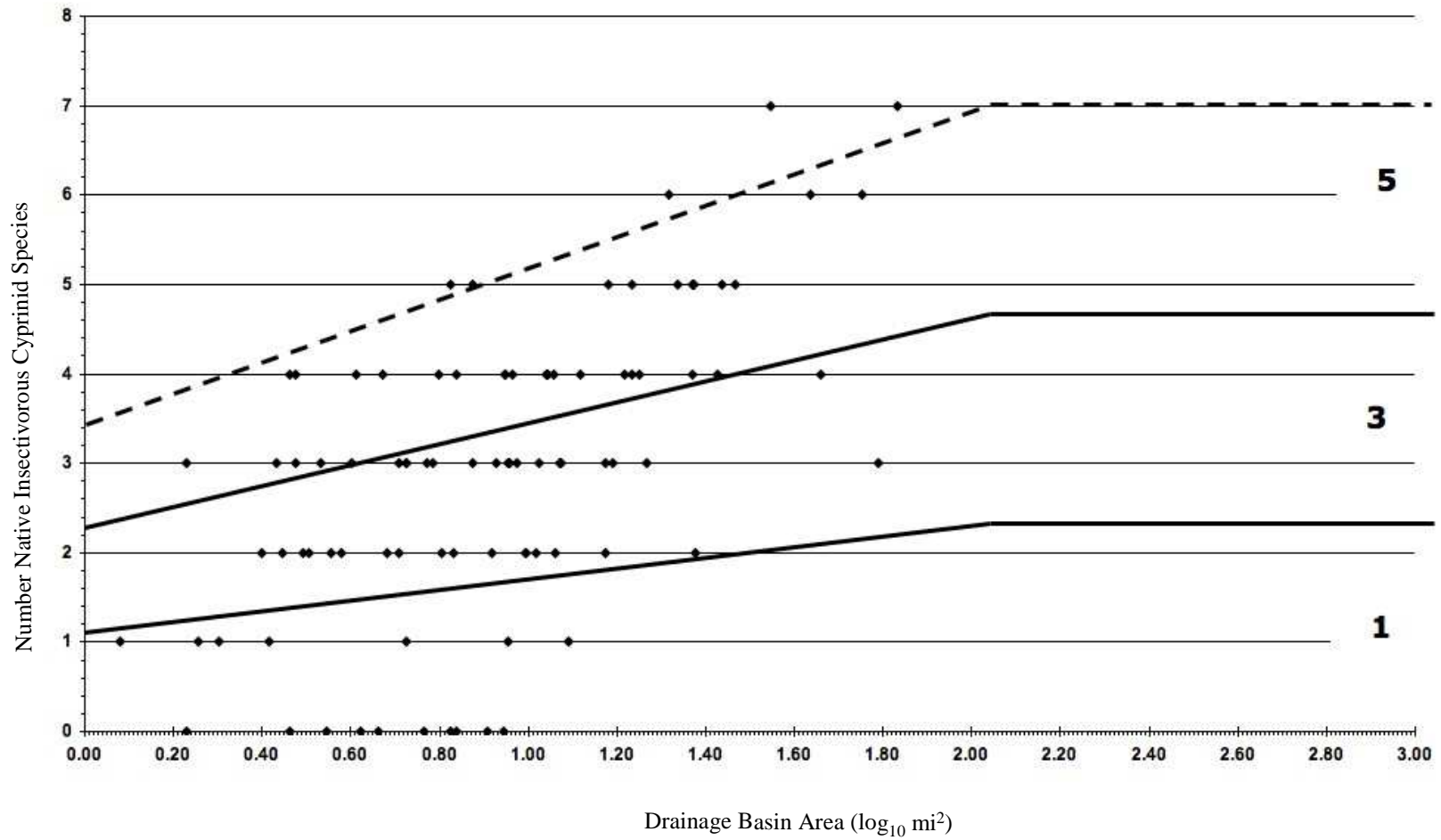
Metric 3b Coosa. Total number of native centrarchid species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



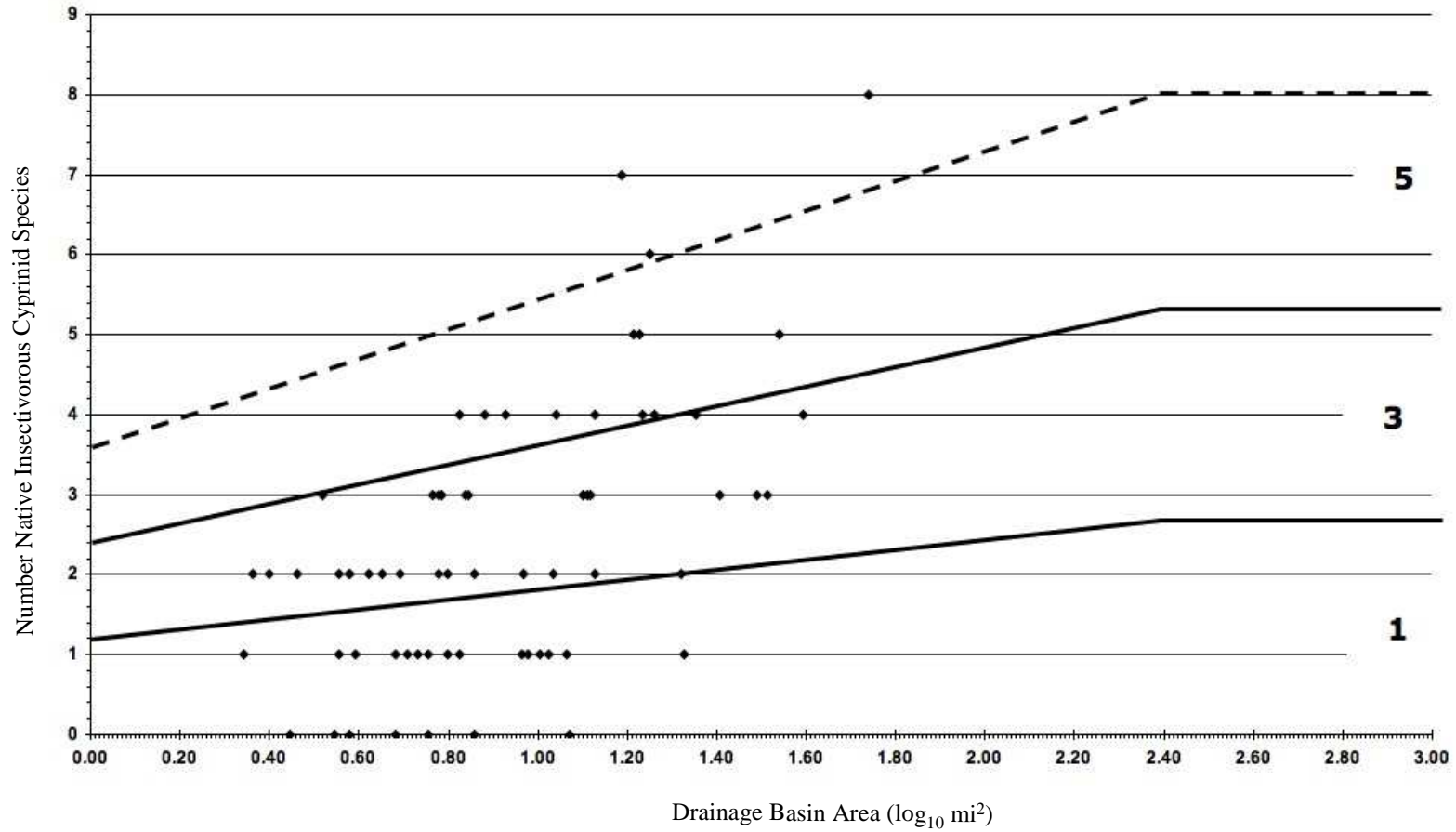
Metric 3b Tennessee. Total number of native centrarchid species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



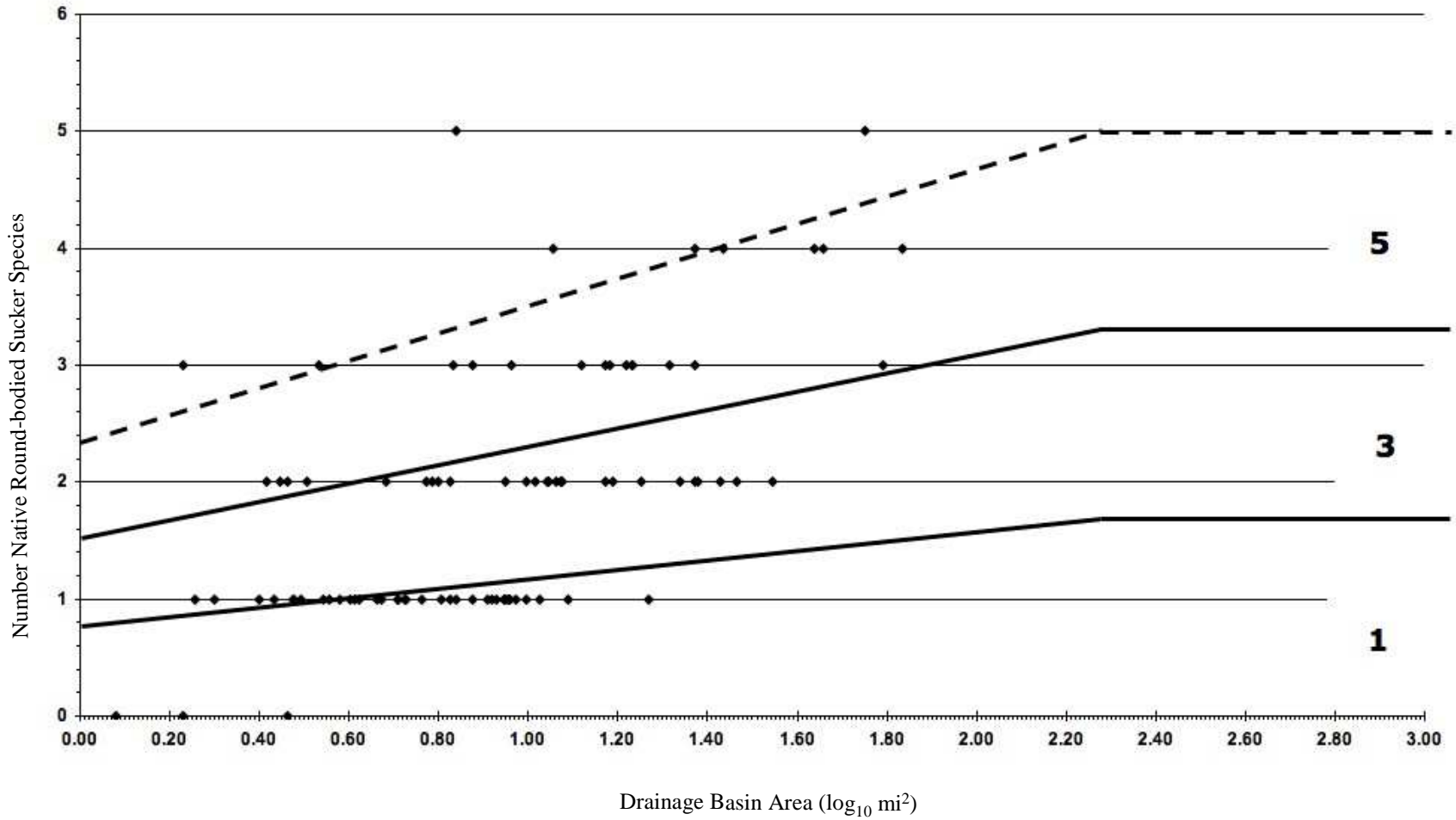
Metric 4 Coosa. Total number of native insectivorous cyprinid species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



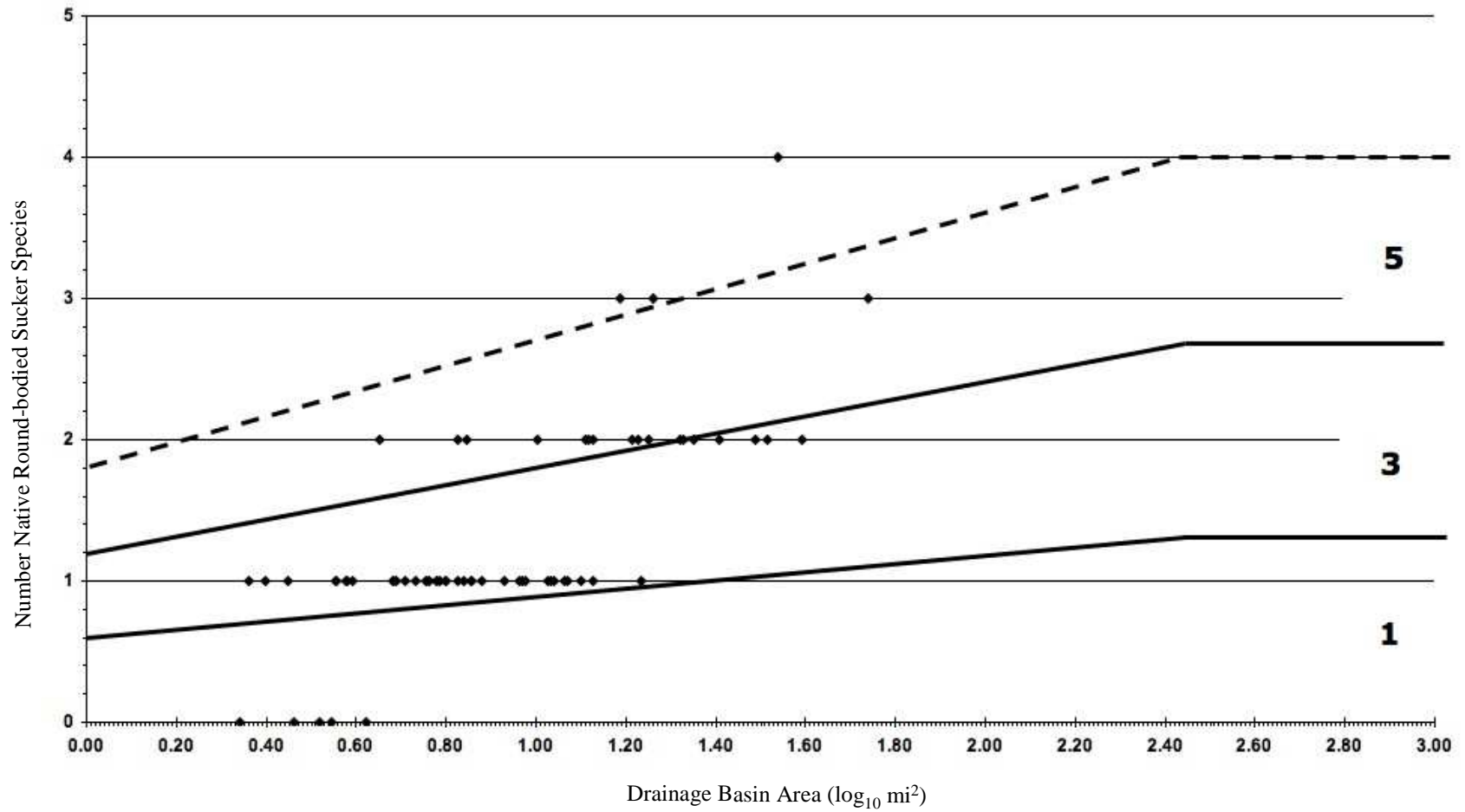
Metric 4 Tennessee. Total number of native insectivorous cyprinid species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



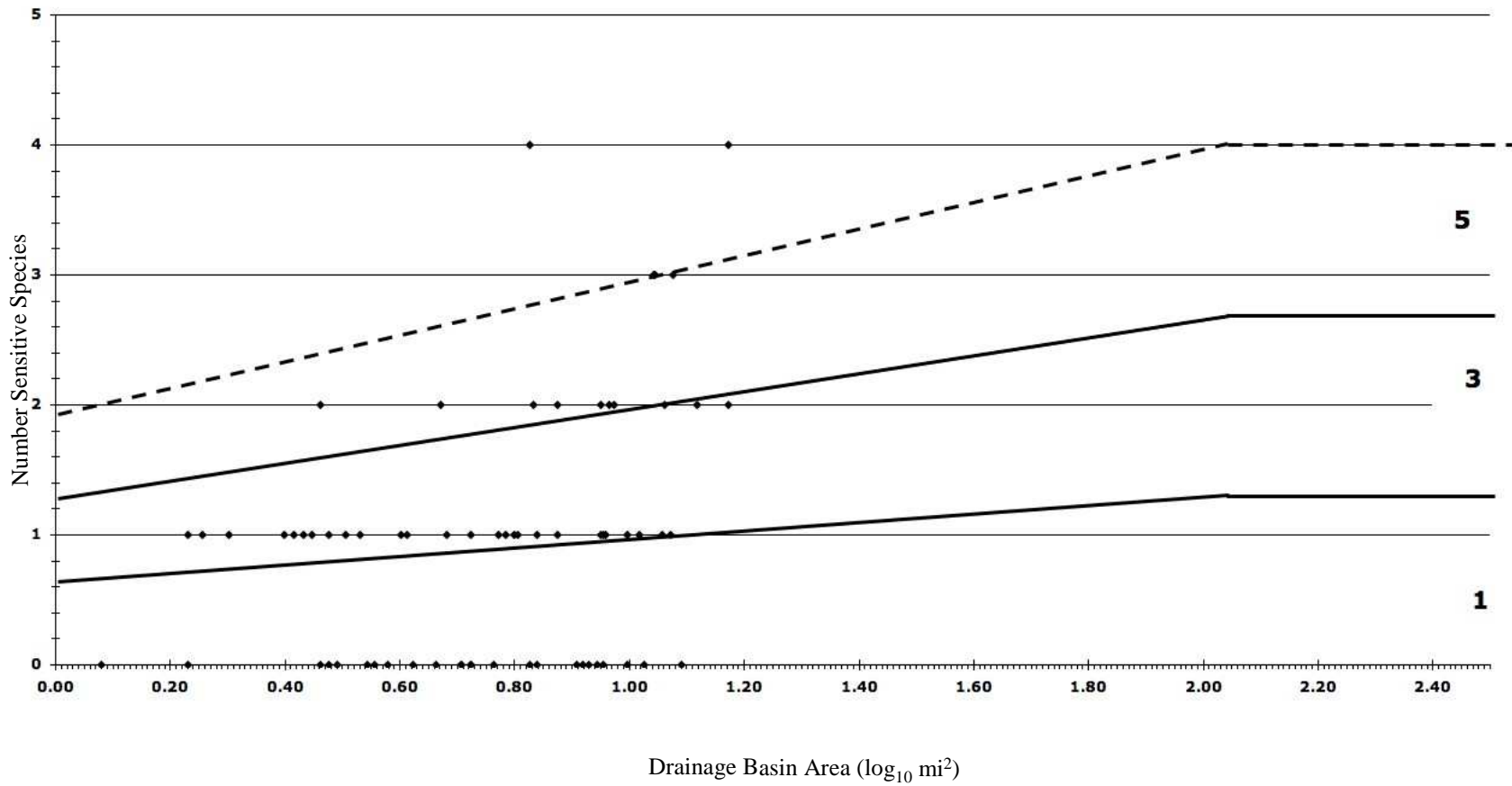
Metric 5 Coosa. Total number of native round-bodied sucker species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



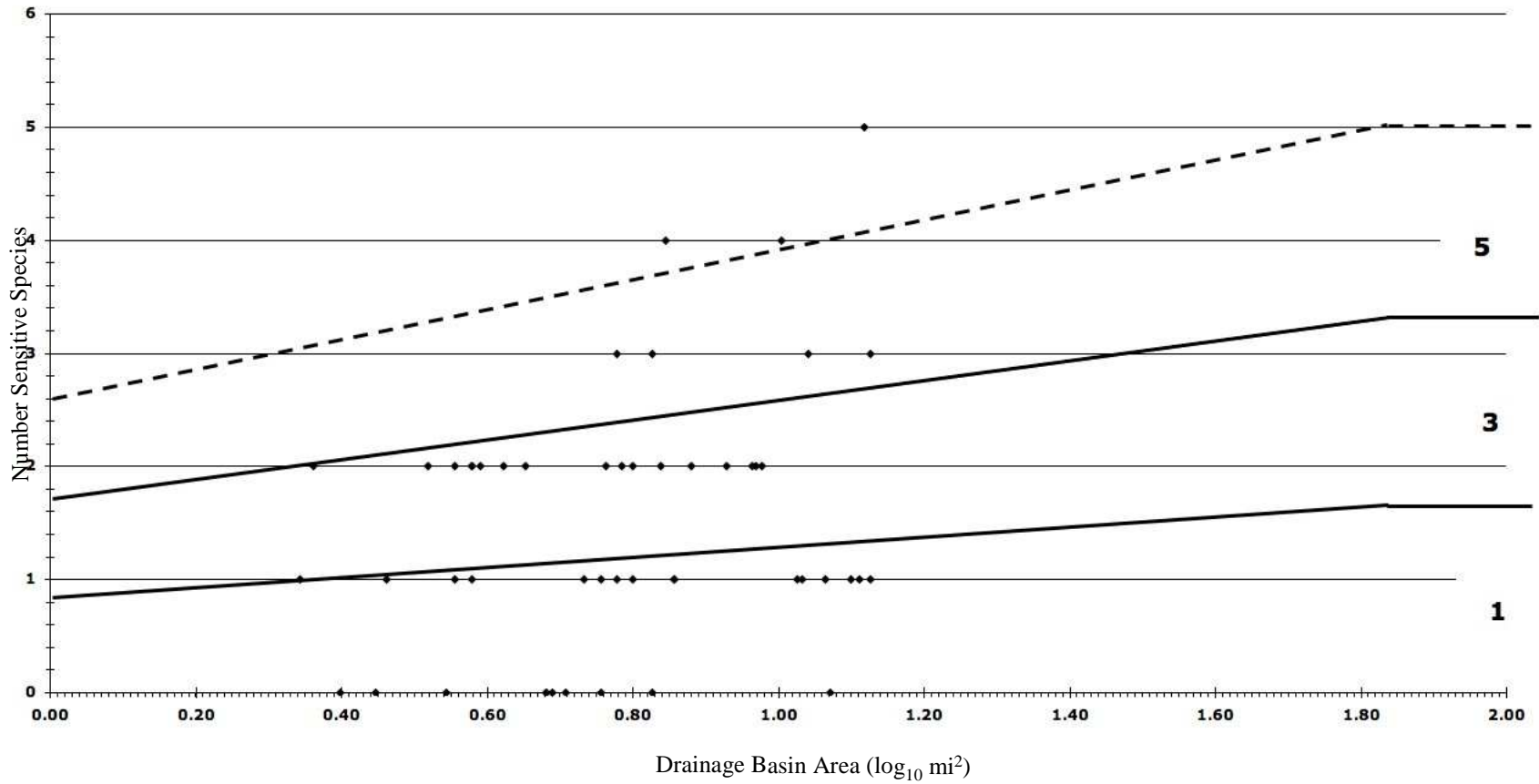
Metric 5 Tennessee. Total number of native round-bodied sucker species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



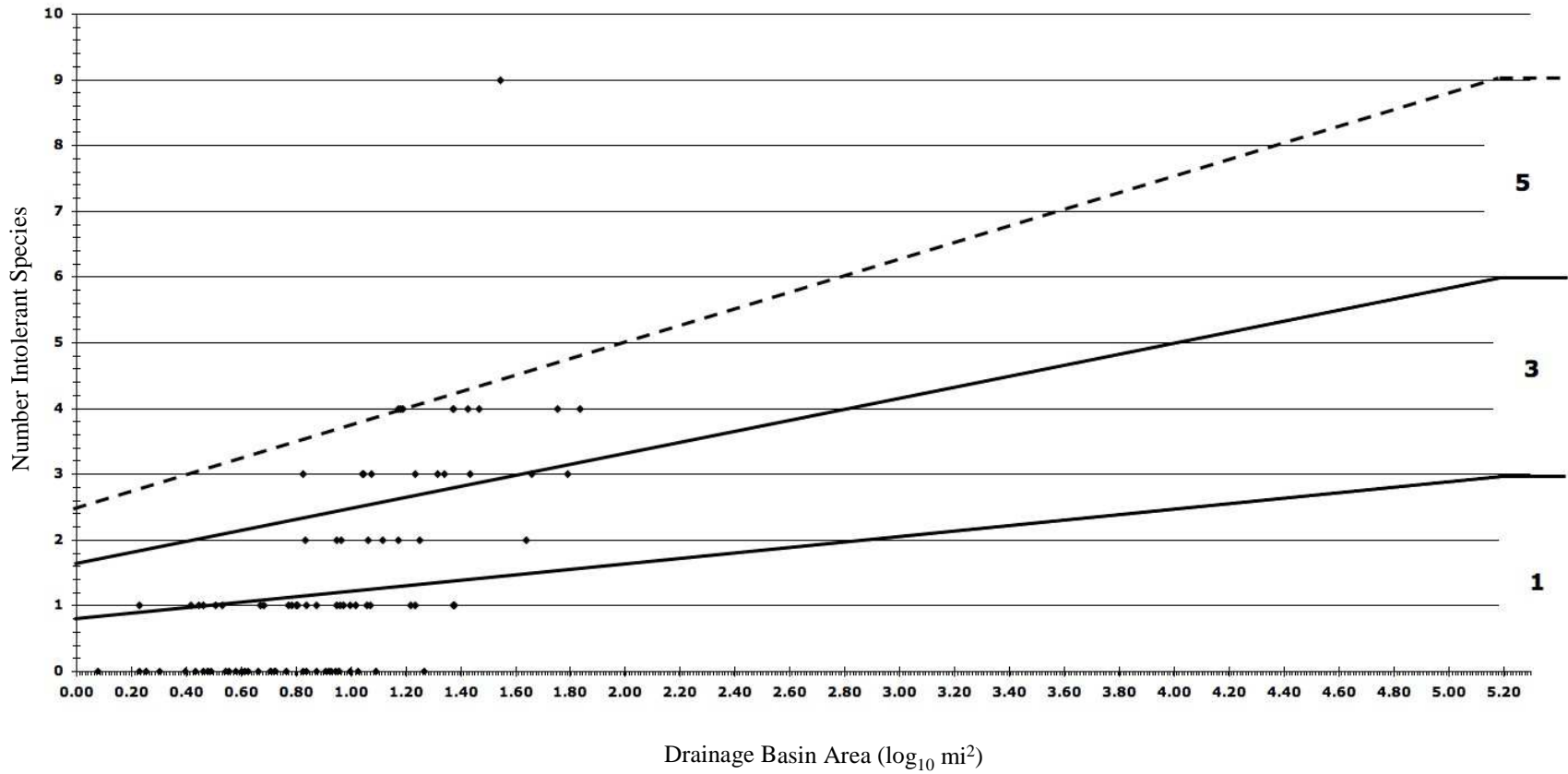
Metric 6a Coosa. Total number of sensitive species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



Metric 6a Tennessee. Total number of sensitive species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



Metric 6b Coosa. Total number of intolerant species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.



Metric 6b Tennessee. Total number of intolerant species in the Blue Ridge ecoregion plotted against the transformed drainage basin area. Maximum species richness denoted by dashed line.

