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Appendix A1

Species traits used in the regression tree analysis of temporal persistence. Data are from Frimpong and Angermeier (2009) unless otherwise noted. Physiographic preference categories were defined from Jenkins and Burkhead (1994): 'montane' species tend to occupy steep mountain streams with > 50% stream length in riffles or cascades; 'upland' species tend to occupy streams of moderate gradient with runs and riffles occupying 10–50% of stream length; 'lowland' species tend to occupy slow moving, low-gradient streams characteristic of the piedmont and coastal plains physiographic regions. Reproductive guilds were defined by Balon (1981). Variables denoted with superscript 'a' are taken from Hitt and Angermeier (2008b).

Family	Species	Physiographic preference	Habitat		Water velocity preference	Native status		Reproduction/life history	
			Stream size preference ^a	Vertical position ^a		Native in the New River basin	Age of female maturity (year)	Batch spawning	
Catostomidae	<i>Catostomus commersoni</i>	generalist	creek/river	benthic	generalist	yes	3.0	no	
	<i>Erinnyzon oblongus</i>	lowland	creek/river	benthic	limnophilic	no	2.0	no	
	<i>Hypentelium nigricans</i>	montane	creek/river	benthic	rheophilic	yes	3.0	no	
Centrarchidae	<i>Ambloplites rupestris</i>	generalist	creek/river	column	limnophilic	no	3.0	no	
	<i>Lepomis auritus</i>	lowland	creek/river	column	limnophilic	no	2.0	yes	
	<i>L. cyanellus</i>	lowland	creek/river	column	limnophilic	yes	2.0	no	
	<i>L. macrochirus</i>	lowland	creek/river	column	limnophilic	no	2.0	yes	
	<i>Micropterus dolomieu</i>	generalist	creek/river	column	rheophilic	no	3.5	no	
Cottidae	<i>Cottus bairdi</i>	montane	creek	benthic ^a	rheophilic	yes	2.0	no	
	<i>C. caroliniae</i>	upland	creek/river	benthic	rheophilic	yes	2.0	no	
Cyprinidae	<i>Campostoma anomalum</i>	generalist	creek/river	benthic	rheophilic	yes	2.5	no	
	...								
...	<i>Clinostomus funduloides</i>	montane	creek	column	limnophilic	yes	2.0	no	
	<i>Cyprinella galactura</i>	upland	creek/river	column	limnophilic	no	1.5	yes	
...	<i>Exoglossum laurae</i>	montane	creek	column	limnophilic	yes	2.0	no	
	<i>Lexilus albeolus</i>	upland	creek/river	column	limnophilic	yes	1.0	no	
	<i>L. cerasinus</i>	upland	creek	column	rheophilic	no	1.5	no	
	<i>Lythurus ardens</i>	montane	creek/river	column	limnophilic	yes	1.0	no	
	<i>Nocomis leptocephalus</i>	montane	creek	column	generalist	yes	1.5	yes	
	<i>Nocomis platyrhynchus</i>	montane	river	column	rheophilic	yes	2.5	no	
	<i>Notropis photogenis</i>	upland	river	column	limnophilic	yes	2.0	no	
	<i>N. telescopus</i>	montane	creek/river	column	limnophilic	no	1.5	no	
	<i>Phoxinus oreas</i>	montane	creek	column	limnophilic	yes	1.5	no	
	<i>Pimephales notatus</i>	generalist	creek/river	column	generalist	yes	1.0	yes	
	<i>Rhinichthys atratulus</i>	montane	creek	column	rheophilic	yes	1.5	no	
	<i>R. cataractae</i>	generalist	creek/river	benthic	rheophilic	yes	2.5	no	

	<i>Semotilus atromaculatus</i>	generalist	creek	column	limnophilic	yes	2.0	no
Ictaluridae	<i>Noturus insignis</i>	generalist	creek/river	benthic	generalist	yes	2.0	no
Percidae	<i>Etheostoma blennioides</i>	montane	river	benthic	rheophilic	yes	1.5	yes
	<i>E. flabellare</i>	montane	creek/river	benthic	rheophilic	yes	1.0	yes
	<i>E. osburni</i>	montane	creek/river	benthic	rheophilic	yes	2.0	no
	<i>Percina roanoka</i>	upland	creek/river	benthic	rheophilic	no	1.5	no
Salmonidae	<i>Oncorhynchus mykiss</i>	montane	creek	column	rheophilic	no	4.0	no
	<i>Salmo trutta</i>	montane	creek	column	rheophilic	no	4.0	no
	<i>Salvelinus fontinalis</i>	montane	creek	column	limnophilic	yes	4.0	no

Species	Fecundity	Longevity (year)	Reproduction/life history			Reproductive guild	Benthic feeding only	Trophic	
			Maximum total length (cm TL)	Mound spawner	Mound spawning			Trophic guild ^a	Trophic guild ^a
<i>Catostomus commersoni</i>	50000	8.0	64.0	no	open	yes	omnivore-herbivore	omnivore-herbivore	
<i>Erimyzon oblongus</i>	83013	5.5	36.0	no	open	no	invertebrate	invertebrate	
<i>Hypentelium nigricans</i>	30000	11.0	61.0	no	open	yes	invertebrate	invertebrate	
<i>Ambloplites rupestris</i>	11000	8.0	43.0	no	saucer	no	invertebrate-piscivore	invertebrate-piscivore	
<i>Lepomis auritus</i>	10000	6.0	30.5	no	saucer	no	invertebrate-piscivore	invertebrate-piscivore	
<i>L. cyanellus</i>	10000	8.0	31.0	no	saucer	no	invertebrate-piscivore	invertebrate-piscivore	
<i>L. macrochirus</i>	50000	10.0	41.0	no	saucer	no	invertebrate	invertebrate	
<i>Micropterus dolomieu</i>	27000	15.0	69.0	no	saucer	no	invertebrate-piscivore	invertebrate-piscivore	
<i>Cottus bairdi</i>	176	6.0	15.0	no	cavity	yes	invertebrate	invertebrate	
<i>C. caroliniae</i>	475	5.0	18.0	no	cavity	yes	invertebrate	invertebrate	
<i>Camptostoma anomalum</i>	4800	5.0	22.0	yes	hider	yes	omnivore-herbivore	omnivore-herbivore	
<i>Glinostomus funduloides</i>	560	4.0	11.0	yes	hider	no	invertebrate	invertebrate	
<i>Cyprinella galactura</i>	1815	3.5	15.0	no	hider	no	invertebrate	invertebrate	
<i>Exoglossum laurae</i>	1800	4.0	16.0	no	mound	yes	invertebrate	invertebrate	
<i>Luxilus albeolus</i>	1482	3.0	13.0	yes	hider	no	invertebrate	invertebrate	
<i>L. cerasinus</i>	1500	4.0	11.0	yes	hider	no	invertebrate	invertebrate	
<i>Lythrurus ardens</i>	1000	2.5	8.5	yes	hider	no	invertebrate	invertebrate	
<i>Nocomis leptocephalus</i>	800	2.5	26.0	yes	mound	no	omnivore-herbivore	omnivore-herbivore	
<i>Nocomis platyrhynchus</i>	1000	4.0	21.4	no	mound	no	invertebrate	invertebrate	
...									
<i>Notropis photogenis</i>	4500	3.0	14.0	no	open	no	invertebrate	invertebrate	
<i>N. telescopus</i>	1000	3.0	9.4	yes	hider	no	invertebrate	invertebrate	
<i>Phoxinus phoxinus</i>	1000	3.0	7.2	yes	hider	yes	omnivore-herbivore	omnivore-herbivore	
<i>Pimephales notatus</i>	4195	3.5	11.0	no	cavity	no	omnivore-herbivore	omnivore-herbivore	
<i>Rhinichthys atratulus</i>	2674	3.5	10.0	yes	hider	no	invertebrate	invertebrate	
<i>R. cataractae</i>	10000	5.0	22.5	yes	hider	yes	invertebrate	invertebrate	
<i>Semotilus atromaculatus</i>	7157	5.0	30.0	no	mound	no	invertebrate-piscivore	invertebrate-piscivore	
<i>Noturus insignis</i>	223	4.0	15.0	no	cavity	yes	invertebrate	invertebrate	
<i>Etheostoma blennioides</i>	2000	5.0	17.0	no	open	yes	invertebrate	invertebrate	
<i>E. flabellare</i>	467	4.0	8.4	no	cavity	yes	invertebrate	invertebrate	

<i>E. osburni</i>	1000	3.0	10.0	no	hider	yes	invertivore
<i>Percina roanoka</i>	800	3.0	7.8	no	hider	yes	invertivore
<i>Oncorhynchus mykiss</i>	27000	7.0	120.0	no	hider	no	invertivore-piscivore
<i>Salmo trutta</i>	7500	18.0	140.0	no	hider	no	invertivore-piscivore
<i>Salvelinus fontinalis</i>	6811	15.0	86.0	no	hider	No	invertivore-piscivore

Appendix A2

Temporal changes in fish species occurrence (X) within Spruce Run, Virginia, USA. Site numbers increase in a downstream direction (Fig. 1).

Species	Burton and Odum (1945) sites										Current study sites									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
<i>Oncorhynchus mykiss</i>	X		X	X		X		X				X		X	X		X	X	X	X
<i>Rhinichthys atratulus</i>	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Clinostomus funduloides</i>	X	X		X	X				X		X	X	X	X	X	X	X	X	X	
<i>Cottus bairdi</i>		X				X		X	X	X										
<i>Salvelinus fontinalis</i>			X		X															
<i>Semotilus atromaculatus</i>			X					X												
<i>Pimephales notatus</i>				X					X											
<i>Rhinichthys cataractae</i>					X	X		X	X	X										
<i>Ambloplites rupestris</i>					X		X							X						
<i>Lepomis macrochirus</i>					X		X							X						
<i>Cottus carolinae</i>						X			X	X										
<i>Nocomis leptcephalus</i>						X			X	X	X	X	X	X	X	X	X	X	X	X
<i>Catostomus commersoni</i>										X										
...																				
<i>Hypentelium nigricans</i>									X	X										
<i>Notropis photogenis</i>									X	X										
<i>Luxilus albeolus</i>									X	X										
<i>Etheostoma flabellare</i>									X	X										
<i>Etheostoma blennioides</i>									X	X										
<i>Etheostoma osburni</i>										X										
<i>Phoxinus oreas</i>											X	X	X	X	X	X	X	X	X	X
<i>Camptostoma anomalum</i>																	X	X		X

Appendix A3

Temporal changes in fish species occurrence (X) within Sinking Creek, Virginia, USA. Site numbers increase in a downstream direction (Fig. 1).

Species	Burton and Odum (1945) sites												Current study sites												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	13
<i>Rhinichthys atratulus</i>	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Clinostomus funduloides</i>	X	X					X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Cottus bairdi</i>	X	X	X		X	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X
<i>Cottus carolinae</i>	X	X			X		X					X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Catostomus commersoni</i>				X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X			X
<i>Hypentelium nigricans</i>				X	X	X			X	X			X	X			X		X	X	X	X	X	X	X
<i>Campostoma anomalum</i>				X		X			X		X		X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Nocomis platyrhynchus</i>				X				X			X														
<i>Notropis photogenis</i>				X	X		X					X													
<i>Pimephales notatus</i>				X				X				X	X		X	X	X	X	X			X	X		X
<i>Etheostoma flabellare</i>					X				X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Semotilus atromaculatus</i>						X	X																		
<i>Rhinichthys cataractae</i>							X													X		X	X	X	X
...																									
<i>Oncorhynchus mykiss</i>							X								X	X	X				X	X	X	X	X
<i>Etheostoma blennioides</i>											X								X						X
<i>Ambloplites rupestris</i>								X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Exoglossum laurae</i>								X	X	X	X					X					X	X			X
<i>Micropterus dolomieu</i>									X				X	X	X	X		X							
<i>Lepomis macrochirus</i>									X					X				X					X	X	
<i>Luxilus albeolus</i>											X												X		X
<i>Etheostoma osburni</i>												X													
<i>Nocomis leptcephalus</i>													X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Luxilus cerasinus</i>													X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Notropis telescopus</i>													X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Lythurus ardens</i>													X	X	X	X	X	X	X	X	X	X			X
<i>Lepomis cyanellus</i>										X				X	X				X				X		
<i>Phoxinus oreas</i>																		X	X	X					
<i>Noturus insignis</i>														X									X		
<i>Lepomis auritus</i>													X	X											
...																									
<i>Salmo trutta</i>																							X		
<i>Cyprinella galactura</i>																								X	X

Appendix A4

Temporal changes in fish species occurrence (X) within Little Stony Creek, Virginia, USA. Site numbers increase in a downstream direction (Fig. 1).

Species	Burton and Odum (1945) sites														Current study sites											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12
<i>Salvelinus fontinalis</i>	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X
<i>Rhinichthys atratulus</i>					X	X	X		X			X	X		X	X	X		X	X	X	X	X	X	X	X
<i>Etheostoma flabellare</i>							X		X			X	X		X	X	X	X	X	X	X	X	X	X	X	
<i>Oncorhynchus mykiss</i>								X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
<i>Cottus bairdi</i>											X	X	X								X	X	X	X	X	X
<i>Cottus carolinae</i>												X	X								X			X	X	
<i>Campostoma anomalum</i>												X	X											X	X	
<i>Luxilus albeolus</i>												X														X
<i>Rhinichthys cataractae</i>												X									X	X	X	X	X	
<i>Catostomus commersoni</i>												X			X	X						X	X		X	X
<i>Ambloplites rupestris</i>																					X					
<i>Phoxinus oreas</i>																										X
<i>Notropis photogenis</i>																										X
...																										
<i>Erimyzon oblongus</i>																										X
<i>Percina roanoka</i>																										X
<i>Clinostomus funduloides</i>																										X

Appendix A5

Importance values for regression tree analysis of species traits and temporal persistence. Importance scores range from 0 (unimportant) to 100 (most important) and gauge the explanatory power of each variable across all nodes within the optimal model (De'ath and Fabricius 2000). Variables not selected in an optimal model can still attain large importance scores due to strong collinearity with variables occurring in the model.

Site-scale model		Stream-scale model	
Variable	Importance	Variable	Importance
Age of female maturity	100.0	native status	100.0
<i>Nocomis</i> nest association	88.5	<i>Nocomis</i> nest association	80.0
Longevity	85.0	longevity	47.8
Fecundity	73.5	reproductive guild	45.3
Body size	69.8	fecundity	22.4
Trophic guild	50.8	age of female maturity	17.3
Reproductive guild	42.2	body size	13.3
Batch spawning	36.5	physiographic preference	0.0
Water velocity preference	33.5	water velocity preference	0.0
Stream size preference	21.1	trophic	0.0
Physiographic preference	1.3	batch spawning	0.0
Obligate benthic feeding	0.2	obligate benthic feeding	0.0
Native status	0.0	vertical position	0.0
Vertical position	0.0	stream size preference	0.0