AN ASSESSMENT of "HOT SPOTS" & PRIORITY WATERSHEDS
for Conservation of Imperiled Freshwater Mussels and Fishes in Kentucky

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Pyramid Pigtoe
Pleurobema rubrum

Stargazing Minnow
Phenacobius uranops

Cumberlandian Combshell
Epioblasma brevidens

Cumberland Elktoe
Alasmidonta atropurpurea

Tan Riffleshell
Epioblasma florentina walkeri

Spotted Darter
Etheostoma maculatum

Fat Pocketbook
Potamilus capax

Texas Lilliput
Toxolasma texasiensis

Longsolid
Fusconaia subrotunda subrotunda

Cypress Minnow
Hybognathus hayi

Smallscale Darter
Etheostoma microlepidum

Bleufer
Potamilus purpuratus

Elktoe
Alasmidonta marginata

Orangefoot Pimpleback
Plethobasus cooperianus

Least Madtom
Noturus hildebrandi

Purple Lilliput
Toxolasma lividus

Salamander Mussel
Simpsonaias ambigua

Rough Pigtoe
Pleurobema plenum

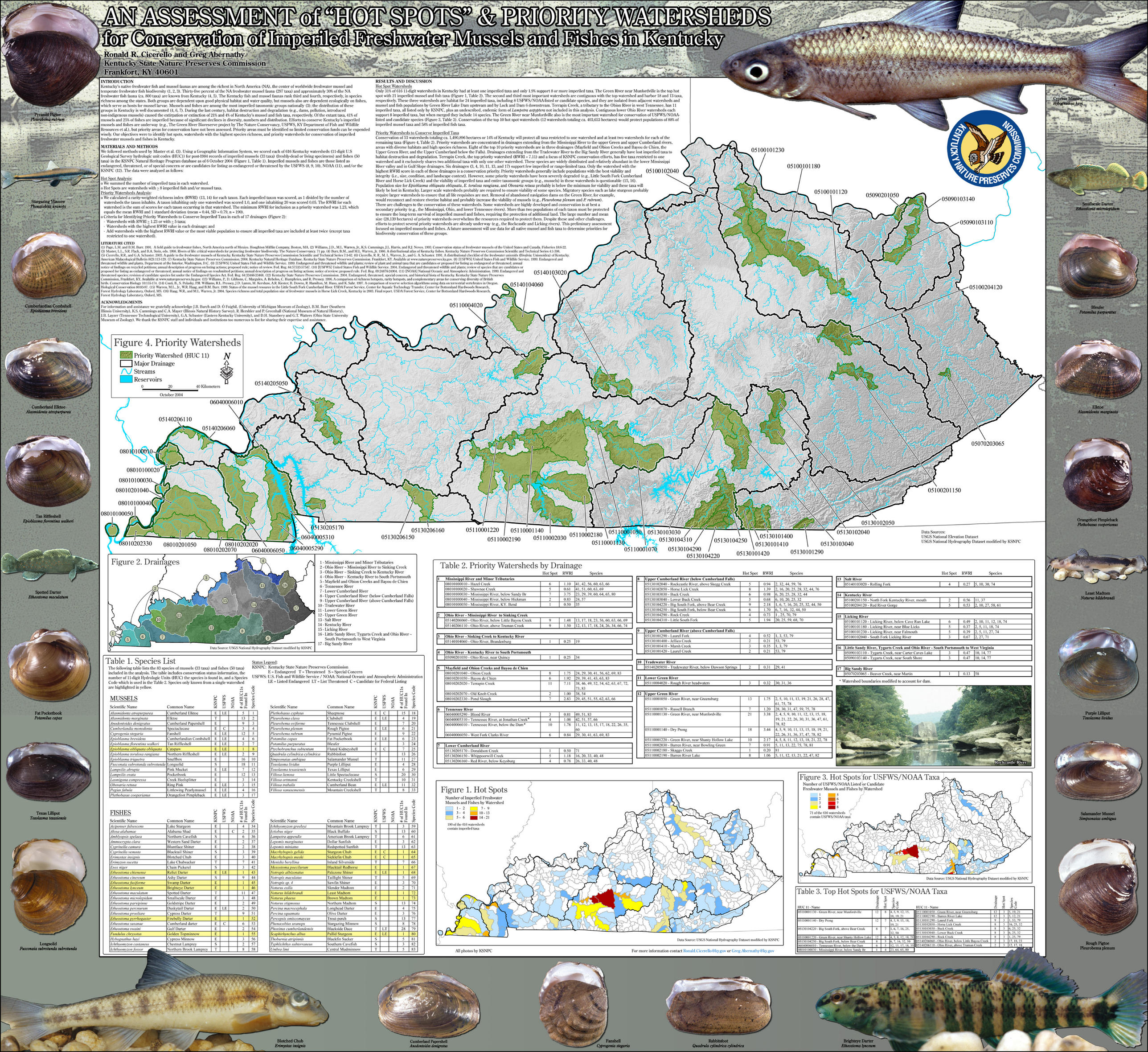

Figure 4. Priority Watersheds

Priority Watershed (HUC 11)
Major Drainage
Streams
Reservoirs
N
0 20 40 Kilometers
October 2004

INTRODUCTION

Kentucky's native freshwater fish and mussel faunas are among the richest in North America (NA), the center of worldwide freshwater mussel and temperate freshwater fish biodiversity (1, 2, 3). Thirty-five percent of the NA freshwater mussel fauna (297 taxa) and approximately 30% of the NA freshwater fish fauna (ca. 800 taxa) are known from Kentucky (4, 5). The Kentucky fish and mussel faunas rank third and fourth, respectively, in species richness among the states. Both groups are dependent upon good physical habitat and water quality, but mussels also are dependent ecologically on fishes, which serve as hosts for mussel larvae. Mussels and fishes are among the most imperiled taxonomic groups nationally (3); the distribution of these groups in Kentucky is well documented (4, 6, 7). During the last century, habitat destruction and degradation (e.g., dams, pollution, introduced non-indigenous mussels) caused the extirpation or extinction of 21% and 4% of Kentucky's mussel and fish taxa, respectively. Of the extant taxa, 41% of mussels and 25% of fishes are imperiled because of significant declines in diversity, numbers and distribution. Efforts to conserve Kentucky's imperiled mussels and fishes are underway (e.g., The Green River Bioreserve project by The Nature Conservancy, USFWS, KY Department of Fish and Wildlife Resources et al.), but priority areas for conservation have not been assessed. Priority areas must be identified so limited conservation funds can be expended wisely. Our objectives were to identify hot spots, watersheds with the highest species richness, and priority watersheds for conservation of imperiled freshwater mussels and fishes in Kentucky.

MATERIALS AND METHODS

We followed methods used by Master et al. (3). Using a Geographic Information System, we scored each of 616 Kentucky watersheds (11-digit U.S Geological Survey hydrologic unit codes (HUC)) for post-1984 records of imperiled mussels (23 taxa) (freshly-dead or living specimens) and fishes (50 taxa) in the KSNPC Natural Heritage Program database as of 6 October 2004 (Figure 1, Table 1). Imperiled mussels and fishes are those listed as endangered, threatened, or of special concern or are candidates for listing as endangered or threatened by the USFWS (8, 9, 10), NOAA (11), and/or the KSNPC (12). The data were analyzed as follows:

Hot Spot Analysis:
- o We summed the number of imperiled taxa in each watershed.
- o Hot Spots are watersheds with $\geq$ 8 imperiled fish and/or mussel taxa.

Priority Watersheds Analysis:
- o We calculated a rarity-weighted richness index (RWRI) (13, 14) for each taxon. Each imperiled taxon was scored, as 1 divided by the number of watersheds the taxon inhabits. A taxon inhabiting only one watershed was scored 1.0, and one inhabiting 20 was scored 0.05. The RWRI for each watershed is the sum of scores for each taxon occurring in that watershed. The minimum RWRI for inclusion as a priority watershed was 1.23, which equals the mean RWRI and 1 standard deviation (mean = 0.44, SD = 0.79, n = 190).
- o Criteria for Identifying Priority Watersheds to Conserve Imperiled Taxa in each of 17 drainages (Figure 2):
  - · Watersheds with RWRI $\geq$ 1.23 or with $\geq$ 5 taxa;
  - · Watersheds with the highest RWRI value in each drainage; and
  - · Add watersheds with the highest RWRI value or the most viable population to ensure all imperiled taxa are included at least twice (except taxa restricted to one watershed).

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RESULTS AND DISCUSSION

Hot Spot Watersheds

Only 31% of 616 11-digit watersheds in Kentucky had at least one imperiled taxa and only 1.9% support 8 or more imperiled taxa. The Green River near Munfordville is the top hot spot with 21 imperiled mussel and fish taxa (Figure 1, Table 2). The second and third most important watersheds are contiguous with the top watershed and harbor 18 and 13 taxa, respectively. These three watersheds are habitat for 24 imperiled taxa, including 8 USFWS/NOAA-listed or candidate species, and they are isolated from adjacent watersheds and mussel and fish populations by Green River Lake Dam upstream and by Lock and Dam 6 downstream. Terrapin Creek, a tributary to the Obion River in west Tennessee, has 11 imperiled taxa, all listed only by KSNPC, plus an undescribed, endemic form of *Lampetra aepyptera* not included in this analysis. Contiguous lower Ohio River watersheds each support 8 imperiled taxa, but when merged they include 14 species. The Green River near Munfordville also is the most important watershed for conservation of USFWS/NOAA-listed and candidate species (Figure 3, Table 3). Conservation of the top 10 hot spot watersheds (12 watersheds totaling ca. 403,653 hectares) would protect populations of 88% of imperiled mussel taxa and 58% of imperiled fish taxa.

Priority Watersheds to Conserve Imperiled Taxa

Conservation of 53 watersheds totaling ca. 1,490,886 hectares or 14% of Kentucky will protect all taxa restricted to one watershed and at least two watersheds for each of the remaining taxa (Figure 4, Table 2). Priority watersheds are concentrated in drainages extending from the Mississippi River to the upper Green and upper Cumberland rivers, areas with diverse habitats and high species richness. Eight of the top 10 priority watersheds are in three drainages (Mayfield and Obion Creeks and Bayou de Chien, the Upper Green River, and the Upper Cumberland below the Falls). Drainages extending from the Tradewater River to the Big Sandy River generally have lost imperiled taxa to habitat destruction and degradation. Terrapin Creek, the top priority watershed (RWRI = 7.11) and a focus of KSNPC conservation efforts, has five taxa restricted to one watershed and it exclusively shares two additional taxa with only one other watershed. These species are widely distributed and relatively abundant in the lower Mississippi River valley and in Gulf Slope drainages. Six drainages (3, 4, 10, 11, 13, and 17) support few imperiled or range-limited taxa. Only the watershed with the highest RWRI score in each of these drainages is a conservation priority. Priority watersheds generally include populations with the best viability and integrity (i.e., size, condition, and landscape context). However, some priority watersheds have been severely degraded (e.g., Little South Fork Cumberland River and Horse Lick Creek) and the viability of imperiled taxa and entire taxonomic groups (e.g., mussels) in these watersheds is questionable (15, 16). Population size for *Epioblasma obliquata obliquata*, *E. torulosa rangiana*, and *Obovaria retusa* probably is below the minimum for viability and these taxa will likely be lost in Kentucky. Larger scale watersheds probably are required to ensure viability of some species. Migratory species such as lake sturgeon probably require larger watersheds to ensure that all life requisites are met. Removal of abandoned navigation dams on the Green River, for example, would reconnect and restore riverine habitat and probably increase the viability of mussels (e.g., *Pleurobema plenum* and *P. rubrum*). There are challenges to the conservation of these watersheds. Some watersheds are highly developed and conservation is at best a secondary priority (e.g., the Mississippi, Ohio, and lower Tennessee rivers). More than two populations of each taxon must be protected to ensure the long-term survival of imperiled mussel and fishes, requiring the protection of additional land. The large number and mean size (28,139 hectares) of priority watersheds overwhelms the resources required to protect them. Despite these and other challenges, efforts to protect several priority watersheds are already underway (e.g., the Rockcastle and Licking rivers). This preliminary assessment focused on imperiled mussels and fishes. A future assessment will use data for all native mussel and fish taxa to determine priorities for biodiversity conservation of these groups.

Figure 2. Drainages

1 - Mississippi River and Minor Tributaries
2 - Ohio River – Mississippi River to Sinking Creek
3 - Ohio River – Sinking Creek to Kentucky River
4 - Ohio River – Kentucky River to South Portsmouth
5 - Mayfield and Obion Creeks and Bayou de Chien
6 - Tennessee River
7 - Lower Cumberland River
8 - Upper Cumberland River (below Cumberland Falls)
9 - Upper Cumberland River (above Cumberland Falls)
10 - Tradewater River
11 - Lower Green River
12 - Upper Green River
13 - Salt River
14 - Kentucky River
15 - Licking River
16 - Little Sandy River, Tygarts Creek and Ohio River – South Portsmouth to West Virginia
17 - Big Sandy River

Table 1. Species List

The following table lists the 83 species of mussels (33 taxa) and fishes (50 taxa) included in the analysis. The table includes conservation status information, the number of 11-digit Hydrologic Units (HUC) the species is found in, and a Species Code which is used in the Table 2. Species only known from a single watershed are highlighted in yellow.

Status Legend:
KSNPC: Kentucky State Nature Preserves Commission
E = Endangered T = Threatened S = Special Concern
USFWS: U.S. Fish and Wildlife Service / NOAA: National Oceanic and Atmospheric Administration
LE = Listed Endangered LT = List Threatened C = Candidate for Federal Listing

MUSSELS

Scientific Name	Common Name	KSNPC	USFWS	NOAA	# of HUC11s Found In	Species Code
Alasmidonta atropurpurea	Cumberland Elktoe	E	LE		5	1
Alasmidonta marginata	Elktoe	T			13	2
Anodontoides denigratus	Cumberland Papershell	E			9	3
Cumberlandia monodonta	Spectaclecase	E	C		3	4
Cyprogenia stegaria	Fanshell	E	LE		12	5
Epioblasma brevidens	Cumberlandian Combshell	E	LE		4	6
Epioblasma florentina walkeri	Tan Riffleshell	E	LE		2	7
Epioblasma obliquata obliquata	Catspaw	E	LE		1	8
Epioblasma torulosa rangiana	Northern Riffleshell	E	LE		2	9
Epioblasma triquetra	Snuffbox	E			16	10
Fusconaia subrotunda subrotunda	Longsolid	S			18	11
Lampsilis abrupta	Pink Mucket	E	LE		7	12
Lampsilis ovata	Pocketbook	E			12	13
Lasmigona compressa	Creek Heelsplitter	E			3	14
Obovaria retusa	Ring Pink	E	LE		3	15
Pegias fabula	Littlewing Pearlymussel	E	LE		4	16
Plethobasus cooperianus	Orangefoot Pimpleback	E	LE		3	17
Plethobasus cyphyus	Sheepnose	E	C		15	18
Pleurobema clava	Clubshell	E	LE		4	19
Pleurobema oviforme	Tennessee Clubshell	E			7	20
Pleurobema plenum	Rough Pigtoe	E	LE		6	21
Pleurobema rubrum	Pyramid Pigtoe	E			9	22
Potamilus capax	Fat Pocketbook	E	LE		6	23
Potamilus purpuratus	Bleufer	E			3	24
Ptychobranchus subtentum	Fluted Kidneyshell	E	C		7	25
Quadrula cylindrica cylindrica	Rabbitsfoot	T			13	26
Simpsonaias ambigua	Salamander Mussel	T			11	27
Toxolasma lividus	Purple Lilliput	E			4	28
Toxolasma texasiensis	Texas Lilliput	E			6	29
Villosa lienosa	Little Spectaclecase	S			20	30
Villosa ortmanni	Kentucky Creekshell	T			10	31
Villosa trabalis	Cumberland Bean	E	LE		11	32
Villosa vanuxemensis	Mountain Creekshell	T			8	33

FISHES

Scientific Name	Common Name	KSNPC	USFWS	NOAA	# of HUC11s Found In	Species Code
Acipenser fulvescens	Lake Sturgeon	E			4	34
Alosa alabamae	Alabama Shad	E		C	2	35
Amblyopsis spelaea	Northern Cavefish	S			6	36
Ammocrypta clara	Western Sand Darter	E			2	37
Cyprinella camura	Bluntface Shiner	E			2	38
Cyprinella venusta	Blacktail Shiner	S			3	39
Erimystax insignis	Blotched Chub	E			3	40
Erimyzon sucetta	Lake Chubsucker	T			7	41
Esox niger	Chain Pickerel	S			3	42
Etheostoma chienense	Relict Darter	E	LE		1	43
Etheostoma cinereum	Ashy Darter	S			9	44
Etheostoma fusiforme	Swamp Darter	E			1	45
Etheostoma lynceum	Brighteye Darter	E			1	46
Etheostoma maculatum	Spotted Darter	T			11	47
Etheostoma microlepidum	Smallscale Darter	E			3	48
Etheostoma parvipinne	Goldstripe Darter	E			2	49
Etheostoma percnurum	Duskytail Darter	E	LE		2	50
Etheostoma proeliare	Cypress Darter	T			9	51
Etheostoma pyrrhogaster	Firebelly Darter	E			1	52
Etheostoma tuscumae	Cumberland darter	E	C		6	53
Etheostoma swainii	Gulf Darter	E			2	54
Fundulus chrysotus	Golden Topminnow	E			1	55
Hybognathus hayi	Cypress Minnow	E			3	56
Ichthyomyzon castaneus	Chestnut Lamprey	S			2	57
Ichthyomyzon fossor	Northern Brook Lamprey	T			8	58
Ichthyomyzon greeleyi	Mountain Brook Lamprey	T			3	59
Ictiobus niger	Black Buffalo	S			13	60
Lampetra appendix	American Brook Lamprey	T			6	61
Lepomis marginatus	Dollar Sunfish	E			3	62
Lepomis miniatus	Redspotted Sunfish	T			13	63
Macrhybopsis gelida	Sturgeon Chub	E	C		1	64
Macrhybopsis meeki	Sicklefin Chub	E	C		1	65
Menidia beryllina	Inland Silverside	T			7	66
Moxostoma poecilurum	Blacktail Redhorse	E			1	67
Notropis albizonatus	Palezone Shiner	E	LE		1	68
Notropis maculatus	Taillight Shiner	T			5	69
Notropis sp. 4	Sawfin Shiner	E			3	70
Noturus exilis	Slender Madtom	E			2	71
Noturus hildebrandi	Least Madtom	E			1	72
Noturus phaeus	Brown Madtom	E			1	73
Noturus stigmosus	Northern Madtom	S			13	74
Percina macrocephala	Longhead Darter	E			4	75
Percina squamata	Olive Darter	E			3	76
Percopsis omiscomaycus	Trout-perch	S			13	77
Phenacobius uranops	Stargazing Minnow	S			8	78
Phoxinus cumberlandensis	Blackside Dace	T	LT		28	79
Scaphirhynchus albus	Pallid Sturgeon	E	LE		1	80
Thoburnia atripinnis	Blackfin Sucker	S			5	81
Typhlichthys subterraneus	Southern Cavefish	S			3	82
Umbra limi	Central Mudminnow	T			5	83

Table 2. Priority Watersheds by Drainage

		Hot Spot	RWRI	Species
1	**Mississippi River and Minor Tributaries**			
	08010100010 - Hazel Creek	6	1.10	41, 42, 56, 60, 63, 66
	08010100020 - Shawnee Creek	5	0.61	41, 51, 60, 63, 69
	08010100030 - Mississippi River, below Sandy Br	7	3.75	23, 29, 39, 60, 64, 65, 80
	08010100040 - Mississippi River, below Hickman	2	0.83	24, 57
	08010100050 - Mississippi River, KY. Bend	1	0.50	35
2	**Ohio River - Mississippi River to Sinking Creek**			
	05140206060 - Ohio River, below Little Bayou Creek	9	1.48	13, 17, 18, 23, 56, 60, 63, 66, 69
	05140206110 - Ohio River, above Truman Creek	9	1.50	12, 13, 17, 18, 24, 26, 34, 66, 74
3	**Ohio River - Sinking Creek to Kentucky River**			
	05140104060 - Ohio River, Brandenburg	1	0.25	19
4	**Ohio River - Kentucky River to South Portsmouth**			
	05090201050 - Ohio River, near Quincy	1	0.25	34
5	**Mayfield and Obion Creeks and Bayou de Chien**			
	08010201040 - Obion Creek	8	1.75	24, 29, 30, 41, 56, 62, 69, 83
	08010201050 - Bayou de Chien	6	1.92	29, 39, 41, 43, 63, 83
	08010202020 - Terrapin Creek	11	7.11	38, 46, 49, 52, 54, 62, 63, 67, 72, 73, 83
	08010202070 - Old Knob Creek	2	1.00	38, 54
	08010202330 - Pond Slough	7	2.83	29, 45, 51, 55, 62, 63, 66
6	**Tennessee River**			
	06040005290 - Blood River	3	0.81	49, 51, 83
	06040005310 - Tennessee River, at Jonathan Creek*	4	1.08	42, 51, 57, 66
	06040006010 - Tennessee River, below the Dam*	10	1.78	11, 12, 13, 15, 17, 18, 22, 26, 35, 60
	06040006050 - West Fork Clarks River	6	0.84	29, 30, 41, 63, 69, 83
7	**Lower Cumberland River**			
	05130205170 - Donaldson Creek	1	0.50	71
	05130206150 - Whippoorwill Creek	5	1.18	16, 20, 33, 40, 48
	05130206160 - Red River, below Keysburg	4	0.78	26, 33, 40, 48
8	**Upper Cumberland River (below Cumberland Falls)**			
	05130102040 - Rockcastle River, above Skegg Creek	5	0.94	2, 32, 44, 59, 76
	05130102050 - Horse Lick Creek	8	1.39	2, 16, 20, 25, 28, 32, 44, 76
	05130103030 - Buck Creek	6	0.98	6, 20, 25, 28, 32, 44
	05130103040 - Lower Buck Creek	5	0.68	6, 10, 20, 25, 32
	05130104220 - Big South Fork, above Bear Creek	9	2.18	1, 6, 7, 16, 20, 25, 32, 44, 50
	05130104250 - Big South Fork, below Bear Creek	6	1.70	6, 7, 16, 32, 44, 50
	05130104290 - Rock Creek	4	0.73	1 , 25, 70, 79
	05130104310 - Little South Fork	5	1.94	20, 25, 59, 68, 70
9	**Upper Cumberland River (above Cumberland Falls)**			
	05130101290 - Laurel Fork	4	0.52	1, 3, 53, 79
	05130101400 - Jellico Creek	2	0.21	53, 79
	05130101410 - Marsh Creek	3	0.35	1, 3, 79
	05130101420 - Laurel Creek	2	0.21	53, 79
10	**Tradewater River**			
	05140205050 - Tradewater River, below Dawson Springs	2	0.31	29, 41
11	**Lower Green River**			
	05110004020 - Rough River headwaters	3	0.32	30, 31, 36
12	**Upper Green River**			
	05110001050 - Green River, near Greensburg	13	1.75	2, 5, 10, 11, 13, 19, 21, 26, 28, 47, 61, 75, 78
	05110001070 - Russell Branch	7	1.20	28, 30, 31, 47, 59, 75, 78
	05110001130 - Green River, near Munfordville	21	3.38	2, 4, 5, 9, 10, 11, 12, 13, 15, 18, 19, 21, 22, 26, 30, 31, 36, 47, 61, 78, 82
	05110001140 - Dry Prong	18	3.44	4, 5, 9, 10, 11, 13, 15, 18, 19, 21, 22, 26, 31, 36, 37, 47, 78, 82
	05110001220 - Green River, near Shanty Hollow Lake	10	2.17	4, 5, 8, 11, 12, 13, 18, 21, 22, 78
	05110002030 - Barren River, near Bowling Green	7	0.91	5, 11, 13, 22, 75, 78, 81
	05110002180 - Skaggs Creek	1	0.20	81
	05110002190 - Barren River Lake	8	1.06	5, 11, 12, 13, 21, 22, 47, 82
13	**Salt River**			
	05140103020 - Rolling Fork	4	0.27	5, 10, 30, 74
14	**Kentucky River**			
	05100201150 - North Fork Kentucky River, mouth	2	0.56	11, 37
	05100204120 - Red River Gorge	5	0.53	2, 10, 27, 58, 61
15	**Licking River**			
	05100101120 - Licking River, below Cave Run Lake	6	0.49	2, 10, 11, 12, 18, 74
	05100101180 - Licking River, near Blue Licks	5	0.37	2, 5, 11, 18, 74
	05100101230 - Licking River, near Falmouth	5	0.39	2, 5, 11, 27, 74
	05100102040 - South Fork Licking River	3	0.67	2, 27, 71
16	**Little Sandy River, Tygarts Creek and Ohio River - South Portsmouth to West Virginia**			
	05090103110 - Tygarts Creek, near Carter Caves Lake	3	0.47	10, 14, 77
	05090103140 - Tygarts Creek, near South Shore	3	0.47	10, 14, 77
17	**Big Sandy River**			
	05070203065 - Beaver Creek, near Martin	1	0.13	58

* Watershed boundaries modified to account for dam.

Figure 1. Hot Spots

Number of Imperiled Freshwater Mussels and Fishes by Watershed

1 - 2
3 - 4
5 - 6
7 - 9
10 - 13
14 - 21

190 of the 616 watersheds contain imperiled taxa

Figure 3. Hot Spots for USFWS/NOAA Taxa

Number of USFWS/NOAA Listed or Candidate Freshwater Mussels and Fishes by Watershed

1
2
3
4
5
6
7
8

71 of the 616 watersheds contain USFWS/NOAA taxa

Table 3. Top Hot Spots for USFWS/NOAA Taxa

HUC 11 - Name	Drainage	Hot Spot	Species Code
05110001130 - Green River, near Munfordville	12	8	4, 5, 9, 12, 15, 18, 19, 21
05110001140 - Dry Prong	12	7	4, 5, 9, 15, 18, 19, 21
05130104220 - Big South Fork, above Bear Creek	8	7	1, 6, 7, 16, 25, 32, 50
05110001220 - Green River, near Shanty Hollow Lake	12	6	4, 5, 8, 12, 18, 21
05130104250 - Big South Fork, below Bear Creek	8	5	6, 7, 16, 32, 50
06040006010 - Tennessee River, below the Dam	6	5	12, 15, 17, 18, 35
08010100030 - Mississippi River, below Sandy Br	1	4	23, 64, 65, 80
05110001050 - Green River, near Greensburg	12	3	5, 19, 21
05110002190 - Barren River Lake	12	3	5, 12, 21
05130101290 - Laurel Fork	9	3	1, 53, 79
05130102050 - Horse Lick Creek	8	3	16, 25, 32
05130103030 - Buck Creek	8	3	6, 25, 32
05130103040 - Lower Buck Creek	8	3	6, 25, 32
05130104290 - Rock Creek	8	3	1, 25, 79
05140206060 - Ohio River, below Little Bayou Creek	2	3	17, 18, 23
05140206110 - Ohio River, above Truman Creek	2	3	12, 17, 18

All photos by KSNPC

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Blotched Chub
Erimystax insignis

Cumberland Papershell
Anodontoides denigratus

Fanshell
Cyprogenia stegaria

Rabbitsfoot
Quadrula cylindrica cylindrica

Brighteye Darter
Etheostoma lynceum