FINAL PERFORMANCE REPORT
South Carolina State Wildlife Grant [T-25-R-1]
South Carolina Stream Conservation Planning Project
October 1, 2006 – September 30, 2012

GRANT OBJECTIVES

1. *Data Collection* - Sampling under this grant concluded in FY2011. Data have been entered, QA/QC'd, and now reside on an Oracle database termed 'StreamWeb'.

2. *Communicate Status of Resources* – Using data from StreamWeb, we developed a quantitative and objective method to rank conservation need among species to assist in prioritizing conservation actions. Recent conservation priority designations for South Carolina freshwater fishes such as the Comprehensive Wildlife Conservation Strategy have provided a useful framework for conservation planning and implementation. However, these rankings are often based largely on qualitative observations such as expert-opinion, useful in the absence of a robust data set, but the availability of the South Carolina Stream Assessment data now allows us to objectively assess conservation need among species at the statewide scale. We present a quantitative index assigning conservation priority for South Carolina stream fishes based on multiple attributes related to risk of imperilment including abundance, frequency of occurrence, range size and existing range-wide conservation status.

3. *Model Development and Implementation* - Relationships in the data are being formalized using a machine-learning approach to model-selection and parameter-fitting according to current ecological frameworks placing conditional dependency of biological parameters on habitat conditions which in turn are further dependent on watershed conditions. Future conservation actions will be guided by the models utilizing an adaptive management approach, and other aquatic resource management such as reservoir sport fisheries will likely be improved as well through amelioration of cumulative impacts from upstream drainages. Technology transfer through Web-based applications would allow other interested entities (public and private) to use the support tools to help make and implement more sustainable land and water resource decisions.

ACTIVITY OVERVIEW:

Communicate Status of Resources

Conservation priority indices can provide a quantitative and objective method for ranking conservation need among species given that financial and logistical resources are limited and finite (Freitag and Van Jaarsveld 1997; Branco et al. 2008; Pritt and Frimpong 2010). Recent conservation priority designations for South Carolina freshwater fishes such as the Comprehensive Wildlife Conservation Strategy (CWCS; Kohlsaat et al. 2005) have provided a useful system for conservation planning and implementation. These rankings for freshwater fishes, however, were based largely on qualitative observations or data from often disjunct studies varying widely in spatial scope and methods, presenting challenges when attempting to objectively assess conservation need among species at the statewide scale.

The South Carolina Stream Assessment (SCSA) was initiated to provide a standardized, statewide framework for assessing the status of stream resources and defining relationships between stream integrity and land use change (Scott 2008). Furthermore, the design of the SCSA facilitated the first known quantitative, objective, data-driven conservation ranking system for South Carolina freshwater fishes.

Materials and Methods

Our conservation priority ranking method incorporated four key attributes influencing the likelihood of a species becoming imperiled as a result of anthropogenic alteration of natural ecosystems: (1) abundance, (2) frequency of occurrence, (3) range size / endemism and (4) existing range-wide conservation status. The index was designed under the rationale that conservation priority should be highest for species displaying lower abundance at a statewide scale, less frequent occurrence, a narrower overall distribution in North America, and/or existing recognition of imperilment in previous published assessments. Species exhibiting these characteristics, especially in combination, would be expected to have the greatest risk of decline with increasing anthropogenic alteration of aquatic ecosystems.

Abundance

To assess abundance on a statewide scale, we used estimates of mean statewide density (n per 100 m^2 of stream area) calculated from SCSA randomly selected sites. Three hundred ninety-seven (397) randomly selected sites were sampled from 2006 - 2011 following SCSA Standard Operating Procedures for wadeable streams (SCDNR 2009). For each sample, total abundance (total catch) of each fish species was divided by sample area to produce density (n per 100 m^2):

$$Density \ (n \ per \ 100 \ m^2) = \frac{Species \ abundance}{(sample \ length \ (m) \times mean \ stream \ width \ (m))} \times 100$$

For coastal plain samples in which multiple electrofishing passes were conducted, abundance of each species was summed across passes prior to converting to density. Densities reflect electrofishing yield and were not corrected for sampling efficiency or species detectability. Mean density and variance by species were computed for each watershed size class within each ecobasin using the proc means procedure of SAS version 9.2 (SAS Institute, Inc., Cary, NC, USA). Mean and variance estimates for species densities were then calculated for successive higher spatial strata (ecobasin, ecoregion, river basin and statewide) using the following formulae:

The estimated **mean** response was defined by the formula:

$$\bar{y}_{st} = \frac{\sum_{h=1}^{L} N_h \bar{y}_h}{N};$$

Estimated **variance** was computed as:

$$v(\bar{y}_{st}) = s^2(\bar{y}_{st}) = \frac{1}{N^2} \sum_{h=1}^{L} N_h (N_h - n_h) \frac{s_h^2}{n_h}.$$

Terms and definitions are presented in Table 1 (J. Grego, University of South Carolina) and details of SCSA random site selection and stream resource estimation are described in Kubach (2008) annual progress report, SCDNR Freshwater Fisheries Research.

Table 1.   Terms and definitions for computing estimated mean and variance of statewide stream resource parameters.

Term	Definition
h	Stratum index (h = 1,..., L)
N_h	Number of 100-m reaches in stratum h
N	Total number of 100-m stream reaches in SC
n_h	Number of sampled 100-m reaches in stratum h
n	Total number of sampled 100-m stream reaches
y_{hi}	Response for reach i in stratum h
$\bar{y}_h$	Mean response for stratum h
$\bar{y}_{st}$	Estimated mean response
s_h^2	Sample variance for stratum h

By incorporating factors of stream population size (Nh) from each preceding stratum level, the estimates for mean and variance are weighted according to the actual representation of watersheds and stream resources.

Mean statewide density estimates for each species were then normalized as a percentage of the maximum observed statewide density (*Nocomis leptocephalus*, bluehead chub: 5.38 individuals per 100 m^2). *Gambusia holbrooki* (eastern mosquitofish) exhibited the highest observed statewide density, at 28.41 individuals per 100 m^2; however, we excluded this species from the index due to its extreme abundance which represented an outlier. Final density values were entered into the index as a rational number reflecting values normalized to *N. leptocephalus* (e.g., if density was 44.1% of *N. leptocephalus* density, index value = 44.1).

Frequency of Occurrence
As a measure of species presence across the state, we computed frequency of occurrence. Frequency of occurrence was defined as the percent of sites occupied (out of 397 possible sites) and entered into the index as a rational number (e.g., if present at 34.6% of sites, index value = 34.6).

Range Size / Endemism

Studies have shown relationships between range size and imperilment risk. To quantify range size, we counted the number of drainages in which each species occurred as defined and reported by Warren et al. (2000) in a summary of the southeastern U.S. freshwater fish fauna, including drainages to which a species was introduced. For species with distributions extending beyond the geographic scope of Warren et al. (2000), additional drainages were counted using the watershed distribution map in the NatureServe Explorer database (http://www.natureserve.org/explorer/) following a drainage size scale equal to Warren et al. (2000). A maximum range size of 52 drainages was established to effectively represent species whose ranges encompass an area equal to or greater than that of the entire southeastern United States as defined by Warren et al. (2000). Several freshwater fish species occurring in South Carolina are currently undergoing potential taxonomic revision. In such cases, we followed Rohde et al. (2009) and references therein for current distributional information and used the greatest degree of published or proposed taxonomic distinctiveness in order to account for potential endemism. Range size was included in the index as a whole number equal to the number of drainages from which the species was known, ranging from one to 52.

Priority Score

Priority score was determined for each species by summing the three values for abundance, frequency of occurrence and range size (Table 2). Thus, a lower total score represented a higher conservation priority based on the rationale that species exhibiting low abundance, infrequent occurrence and/or a narrow overall distribution were most likely to decline due to anthropogenic alteration of habitats and ecosystems.

Table 2.   Example of conservation priority scoring system showing values for a relatively high priority species, *Semotilus lumbee* (Sandhills chub), and a low priority species, *Lepomis auritus* (redbreast sunfish).

Measure	Value		Definition
	S. lumbee	*L. auritus*	
Abundance	0.76	45.03	Mean statewide density as percentage of maximum (*Nocomis leptocephalus*)
Frequency of Occurrence	1.26	64.74	Percent of sites occupied statewide
Range Size	3	47	Number of drainages in overall range (Warren et al. 2000)
Priority Score	5.02	156.77	= Sum of values above
Existing Status	-25%	None	*S. lumbee* listed as Vulnerable in Jelks et al. (2008)
Final Priority Score	**3.77**	**156.77**	**Lower score = Higher priority**

Existing Conservation Status

Regardless of status in South Carolina, species known to be declining or at high risk of decline in other portions of their ranges warranted concern. To account for existing conservation status, scores were adjusted for species recognized as imperiled on a range-wide basis in a recent comprehensive assessment of North American fishes (Jelks et al. 2008). Scores for species listed in Jelks et al. (2008) were reduced by a percentage concordant with imperilment status: Endangered = 75% reduction; Threatened = 50%; Vulnerable = 25%. For the revision of the Comprehensive Wildlife Conservation Strategy (2012-2013), any stream fish recognized as imperiled in Jelks et al. (2008) was assigned Priority status regardless of its priority index score.

Exclusions and Additional Considerations

The SCSA focused on wadeable freshwater streams draining watersheds between $4 - 150$ km^2. Although wadeable streams by length comprise about 90% of all stream and river habitats in South Carolina, they do not represent the primary habitat for certain species and therefore we excluded from the rankings species considered to occur principally outside of wadeable streams or otherwise beyond the scope of the SCSA. Species in the following categories were excluded from the rankings: (1) diadromous species except *Anguilla rostrata* (American eel); (2) primarily estuarine species not collected in the SCSA; (3) non-native species not collected in the SCSA.

Prior to assigning final priority status, additional consideration was given to species known to occur primarily outside of wadeable streams, based on best available data and expertise of the Freshwater Fishes Technical Committee. Species falling within the Priority range of the rankings yet known to be secure and stable in habitats other than wadeable streams were evaluated on a case-by-case basis by the Freshwater Fishes Technical Committee. Examples included species occurring primarily in: (1) large (non-wadeable) streams and rivers, (2) lakes and (3) swamps and wetlands.

Results and Discussion

Final rankings were computed for 128 fish species occurring in fresh waters of South Carolina (Table 3). Conservation priority scores ranged from 0.50 (*Moxostoma sp. cf. erythrurum*, Carolina redhorse) to 156.77 (*Lepomis auritus*, redbreast sunfish) and the median score was 30.19, excluding *Gambusia holbrooki* (609.45).

The distribution of priority scores showed a gradual increase in scores from 0.50 to 21.61 (mean score difference of 0.41), at which point scores increased at over twice this margin on average (mean difference 1.20) until reaching 52.0 (Fig. 1). The plateau in scores at 52.0 was a result of several species with large range sizes equal to or exceeding 52 drainages but otherwise not collected or only collected from few sites or in low abundance.

Table 3. Conservation priority rankings for South Carolina stream fishes. See Methods for derivation of abundance, frequency of occurrence (Freq), range size (Range) measures and scoring system. Letters for Jelks 2008 refer to Endangered (E), Threatened (T), Vulnerable (V). Notes codes: 1 = not added as priority species because secure in habitats other than wadeable streams; 2 = automatic priority status due to range-wide imperilment (Jelks et al. 2008); 3 = priority status due to other recognized factors; 4 = insufficient information to remove priority status.

Rank	Scientific Name	Common Name	Abundance	Freq	Range	Jelks 2008	Priority Score	Priority 2012	Priority 2005	Notes
1	*Moxostoma sp. cf. erythrurum*	Carolina redhorse	0.000	0.00	2	E	0.50	YES	High	
2	*Etheostoma mariae*	Pinewoods darter	0.000	0.00	1	V	0.75	YES	High	
3	*Elassoma boehlkei*	Carolina pygmy sunfish	0.000	0.00	2	T	1.00	YES	Highest	
4	*Moxostoma robustum*	Robust redhorse	0.000	0.00	4	E	1.00	YES	Highest	
5	*Elassoma okatie*	Bluebarred pygmy sunfish	0.000	0.00	2	V	1.50	YES	Highest	
6	*Cyprinella sp. cf. zanema*	"Thinlip" chub	0.000	0.00	2		2.00	YES	Highest	
7	*Noturus sp. cf. leptacanthus*	Broadtail madtom	0.000	0.00	3	V	2.25	YES	Highest	
8	*Cyprinella labrosa*	Thicklip chub	0.002	0.50	2		2.51	YES	Moderate	
9	*Notropis spectrunculus*	Mirror shiner	0.000	0.00	3		3.00	YES	Moderate	
10	*Etheostoma flabellare brevispina*	Carolina fantail darter	0.065	0.50	3		3.57	YES	High	
11	*Semotilus lumbee*	Sandhills chub	0.765	1.26	3	V	3.77	YES	Highest	
12	*Notropis chiliticus*	Redlip shiner	0.000	0.00	4		4.00	YES	Moderate	
13	*Notropis alborus*	Whitemouth shiner	0.000	0.00	4		4.00	YES	Moderate	
14	*Cyprinella leedsi*	Bannerfin shiner	0.000	0.00	4		4.00	YES	High	
15	*Cyprinella pyrrhomelas*	Fieryblack shiner	0.278	2.02	2		4.29	YES	Moderate	
16	*Luxilus coccogenis*	Warpaint shiner	0.045	0.25	4		4.30	YES	Moderate	
17	*Cyprinella zanema*	Santee chub	0.229	3.27	1		4.50	YES	High	
18	*Lepisosteus platyrhincus*	Florida gar	0.000	0.00	5		5.00	YES	Moderate	
19	*Cottus bairdi*	Smoky sculpin	1.064	1.01	3		5.07	YES	High	
20	*Moxostoma pappillosum*	V-lip redhorse	0.004	0.76	5		5.76	YES	Moderate	
21	*Salvelinus fontinalis*	S. Appalachian brook trout	0.000	0.00	6		6.00	YES	Moderate	
22	*Micropterus coosae*	Redeye bass	0.729	2.77	3		6.50	YES	Highest	
23	*Etheostoma hopkinsi*	Christmas darter	1.337	4.28	1		6.62	YES	Highest	

Rank	Scientific Name	Common Name	Abundance	Freq	Range	Jelks 2008	Priority Score	Priority 2012	Priority 2005	Notes
24	*Campostoma anomalum michauxi*	Stoneroller	0.013	0.76	6		**6.77**	**YES**	Moderate	
25	*Percina crassa*	Piedmont darter	0.300	3.53	3		**6.83**	**YES**	High	
26	*Etheostoma inscriptum*	Turquoise darter	0.573	3.78	3		**7.35**	**YES**	High	
27	*Notropis leuciodus*	Tennessee shiner	0.000	0.00	8		**8.00**	**YES**	Moderate	
28	*Scartomyzon sp.*	Brassy jumprock	0.078	3.27	5		**8.35**			1
29	*Etheostoma fricksium*	Savannah darter	1.035	5.79	2		**8.83**	**YES**	Highest	
30	*Notropis bifrenatus*	Bridle shiner	0.000	0.00	12	V	**9.00**	**YES**	Highest	
31	*Notropis amoenus*	Comely shiner	0.000	0.00	10		**10.00**	**YES**	Moderate	
32	*Moxostoma collapsum*	Notchlip redhorse	0.095	4.03	7		**11.13**	**YES**	Moderate	
33	*Enneacanthus chaetodon*	Blackbanded sunfish	0.087	1.26	14	V	**11.51**	**YES**	High	
34	*Etheostoma collis*	Carolina darter	3.012	7.56	5	V	**11.68**	**YES**	High	
35	*Etheostoma thalassinum*	Seagreen darter	1.549	9.32	1		**11.87**	**YES**	High	
36	*Elassoma evergladei*	Everglades pygmy sunfish	0.000	0.00	12		**12.00**	**YES**		
37	*Chologaster cornuta*	Swampfish	0.197	3.02	9		**12.22**	**YES**		
38	*Cyprinella nivea*	Whitefin shiner	1.959	5.04	6		**13.00**			1
39	*Cyprinella analostana*	Satinfin shiner	0.000	0.00	13		**13.00**	**YES**	Moderate	
40	*Hybopsis hypsinotus*	Highback chub	3.303	8.06	2		**13.36**	**YES**	Moderate	
41	*Fundulus diaphanus*	Banded killifish	0.000	0.00	14		**14.00**	**YES**	Moderate	
42	*Notropis altipinnis*	Highfin shiner	3.389	5.04	6		**14.43**	**YES**		
43	*Fundulus lineolatus*	Lined topminnow	1.166	2.77	11		**14.94**			1
44	*Rhinichthys atratulus*	Blacknose dace	0.000	0.00	15		**15.00**	**YES**	Moderate	
45	*Cyprinella chloristia*	Greenfin shiner	3.311	9.82	2		**15.13**	**YES**	Moderate	
46	*Etheostoma serrifer*	Sawcheek darter	1.052	6.05	9		**16.10**	**YES**		
47	*Ameiurus brunneus*	Snail bullhead	0.359	9.32	12	V	**16.26**	**YES**	Moderate	
48	*Notropis procne*	Swallowtail shiner	1.032	4.79	14		**19.82**	**YES**		
49	*Notropis scepticus*	Sandbar shiner	3.602	12.59	4		**20.20**	**YES**		
50	*Ameiurus platycephalus*	Flat bullhead	0.898	15.11	11	V	**20.26**	**YES**	Moderate	
51	*Clinostomus funduloides*	Rosyside dace	2.252	5.79	13		**21.05**	**YES**		
52	*Hybopsis rubrifrons*	Rosyface chub	8.655	9.82	3		**21.48**	**YES**	Moderate	

Rank	Scientific Name	Common Name	Abundance	Freq	Range	Jelks 2008	Priority Score	Priority 2012	Priority 2005	Notes
53	*Enneacanthus obesus*	Banded sunfish	1.331	4.28	16		**21.61**	**YES**		
				PRIORITY CUTOFF						
54	*Scartomyzon rupiscartes*	Striped jumprock	2.847	14.61	6		**23.46**			
55	*Heterandria formosa*	Least killifish	4.703	1.76	17		**23.47**			
56	*Noturus leptacanthus*	Speckled madtom	1.522	8.06	14		**23.58**			
57	*Notropis petersoni*	Coastal shiner	2.669	8.82	13		**24.49**			
58	*Notropis maculatus*	Taillight shiner	0.022	0.76	26		**26.78**			
59	*Petromyzon marinus*	Sea lamprey	0.000	0.00	29		**29.00**			
60	*Notropis chalybaeus*	Ironcolor shiner	3.934	2.77	32	V	**29.03**	**YES**		2
61	*Pteronotropis stonei*	Lowland shiner	19.751	13.10	6	V	**29.14**	**YES**	Moderate	2
62	*Hybognathus regius*	Eastern silvery minnow	2.610	5.29	22		**29.90**			
63	*Fundulus chrysotus*	Golden topminnow	0.290	1.76	28		**30.05**			
64	*Poecilia latipinna*	Sailfin molly	0.074	0.25	30		**30.33**			
65	*Ameiurus catus*	White catfish	0.000	0.00	32		**32.00**	**YES**	Moderate	4
66	*Trinectes maculatus*	Hogchoker	0.079	1.01	31		**32.09**			
67	*Etheostoma fusiforme*	Swamp darter	2.571	7.81	22		**32.38**			
68	*Percina nigrofasciata*	Blackbanded darter	2.881	16.12	15		**34.00**			
69	*Morone americana*	White perch	0.000	0.00	40		**40.00**			
70	*Menidia beryllina*	Inland silverside	0.000	0.00	44		**44.00**			
71	*Acantharchus pomotis*	Mud sunfish	5.809	24.43	15		**45.24**		Moderate	
72	*Carpiodes velifer*	Highfin carpsucker	0.000	0.00	46		**46.00**	**YES**	Highest	4
73	*Lepomis punctatus*	Spotted sunfish	14.112	22.92	9		**46.03**			
74	*Opsopoeodus emiliae*	Pugnose minnow	0.120	1.26	45		**46.38**		Moderate	
75	*Morone saxatilis*	Striped bass	0.000	0.00	49		**49.00**	**YES**	Moderate	4
76	*Noturus insignis*	Margined madtom	5.252	25.94	18		**49.20**			
77	*Notropis cummingsae*	Dusky shiner	24.398	16.12	11		**51.52**			
78	*Moxostoma macrolepidotum*	Shorthead redhorse	0.000	0.00	52		**52.00**			
79	*Carpiodes cyprinus*	Quillback	0.000	0.00	52		**52.00**	**YES**	High	4
80	*Rhinichthys cataractae*	Longnose dace	0.000	0.00	52		**52.00**		Moderate	
81	*Carassius auratus*	Goldfish	0.001	0.25	52		**52.25**			

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82	*Pylodictis olivaris*	Flathead catfish	0.007	0.25	52		**52.26**			
83	*Dorosoma cepedianum*	Gizzard shad	0.013	0.25	52		**52.26**			
84	*Pimephales promelas*	Fathead minnow	0.018	0.25	52		**52.27**			
85	*Elassoma zonatum*	Banded pygmy sunfish	4.489	13.85	34		**52.34**			
86	*Fundulus heteroclitus*	Mummichog	0.101	0.25	52		**52.35**			
87	*Salmo trutta*	Brown trout	0.007	0.50	52		**52.51**			
88	*Oncorhynchus mykiss*	Rainbow trout	0.010	0.50	52		**52.51**			
89	*Pomoxis annularis*	White crappie	0.026	0.76	52		**52.78**			
90	*Ictalurus punctatus*	Channel catfish	0.048	0.76	52		**52.80**			
91	*Lepisosteus osseus*	Longnose gar	0.078	0.76	52		**52.83**			
92	*Micropterus dolomieu*	Smallmouth bass	0.055	1.01	52		**53.06**			
93	*Pomoxis nigromaculatus*	Black crappie	0.031	1.76	52		**53.79**			
94	*Ameiurus nebulosus*	Brown bullhead	0.504	1.76	52		**54.27**			
95	*Ameiurus melas*	Black bullhead	0.412	2.02	52		**54.43**			
96	*Enneacanthus gloriosus*	Bluespotted sunfish	11.601	20.40	23		**55.00**			
97	*Umbra pygmaea*	Eastern mudminnow	19.913	18.14	17		**55.05**			
98	*Labidesthes sicculus*	Brook silverside	0.389	3.53	52		**55.92**			
99	*Perca flavescens*	Yellow perch	0.320	4.03	52		**56.35**			
100	*Amia calva*	Bowfin	0.768	5.29	52		**58.06**			
101	*Catostomus commersoni*	White sucker	0.380	6.55	52		**58.93**			
102	*Notropis hudsonius*	Spottail shiner	1.576	6.80	52		**60.38**			
103	*Minytrema melanops*	Spotted sucker	0.708	7.81	52		**60.52**			
104	*Erimyzon sucetta*	Lake chubsucker	4.726	8.82	52		**65.54**			
105	*Lepomis microlophus*	Redear sunfish	1.120	12.59	52		**65.71**			
106	*Erimyzon oblongus*	Creek chubsucker	14.672	36.78	15		**66.45**			
107	*Esox niger*	Chain pickerel	1.223	15.11	52		**68.34**			
108	*Noturus gyrinus*	Tadpole madtom	2.606	14.61	52		**69.22**			
109	*Centrarchus macropterus*	Flier	10.843	17.13	42		**69.97**			
110	*Etheostoma olmstedi*	Tessellated darter	14.161	36.27	20		**70.43**			
111	*Hypentelium nigricans*	Northern hogsucker	5.386	16.62	52		**74.01**			
112	*Lepomis cyanellus*	Green sunfish	5.140	18.64	52		**75.78**			
113	*Notropis chlorocephalus*	Greenhead shiner	53.007	20.91	2		**75.91**		High	
114	*Lepomis gibbosus*	Pumpkinseed	8.006	19.40	52		**79.40**			

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115	*Lepomis marginatus*	Dollar sunfish	26.381	31.23	29		**86.62**			
116	*Notropis lutipinnis*	Yellowfin shiner	68.876	14.36	6		**89.23**			
117	*Micropterus salmoides*	Largemouth bass	3.409	34.51	52		**89.92**			
118	*Anguilla rostrata*	American eel	13.333	24.94	52		**90.27**	**YES**	Highest	3
119	*Notemigonus crysoleucas*	Golden shiner	22.767	23.68	52		**98.44**			
120	*Lepomis gulosus*	Warmouth	9.366	40.81	52		**102.17**			
121	*Ameiurus natalis*	Yellow bullhead	17.644	38.04	52		**107.68**			
122	*Lepomis macrochirus*	Bluegill	24.118	51.13	52		**127.25**			
123	*Semotilus atromaculatus*	Creek chub	50.477	29.97	52		**132.45**			
124	*Aphredoderus sayanus*	Pirate perch	68.382	56.17	22		**146.55**			
125	*Nocomis leptocephalus*	Bluehead chub	100.000	42.07	9		**151.07**			
126	*Esox americanus*	Redfin pickerel	47.574	53.40	52		**152.97**			
127	*Lepomis auritus*	Redbreast sunfish	45.033	64.74	47		**156.77**			
128	*Gambusia holbrooki*	Eastern mosquitofish	528.487	61.96	19		**609.45**			
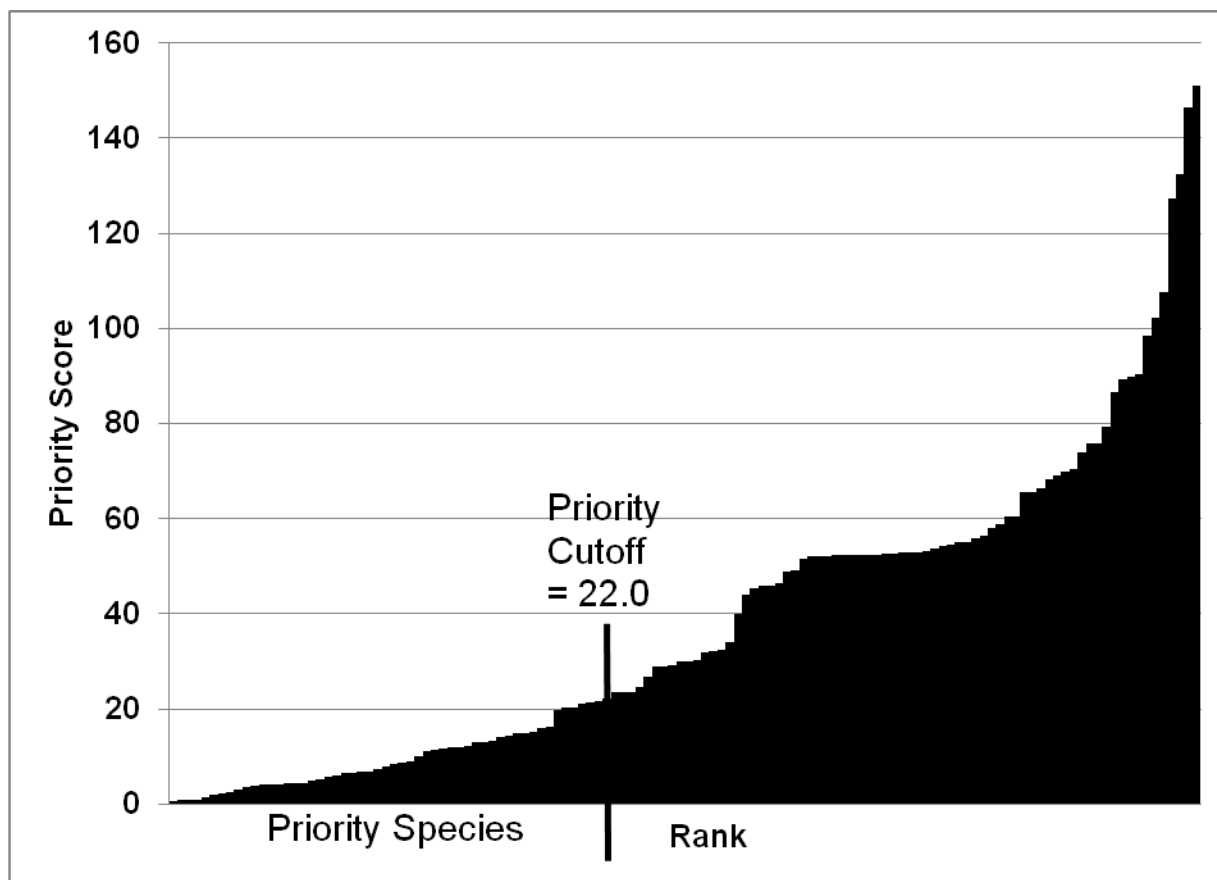
Figure 1.　　Priority score distribution for the 128 freshwater fish species included in the conservation priority index for South Carolina stream fishes. Species with scores less than 22.0 or meeting other specific criteria received priority status. *Gambusia holbrooki* (score = 609.45) is not included in this figure.

Based on the threshold in score distribution at 22.0 and careful consideration of status for species on either side of this score, we established a score of 22.0 as the cutoff for priority status (i.e. priority status if score ≤ 22.0). Fifty-three species exhibited scores less than 22.0 and were proposed for priority status (Table 3). Of these, 42 species (79%) were previously designated as priority species in the CWCS (Kohlsaat et al. 2005).

Two additional species whose scores were outside of priority range were automatically assigned priority status due to range-wide imperilment recognition by Jelks et al. (2008): *Notropis chalybaeus* (ironcolor shiner) and *Pteronotropis stonei* (lowland shiner). *Anguilla rostrata* (American eel) maintained priority status despite its high score of 90.27, due to known conservation concern for this species among experts and its status as a catadromous species facing threats across multiple ecosystems.

All proposed priority species were evaluated by the Freshwater Fishes Technical Committee prior to final assignment. Three proposed priority species were not added due to secure status in habitats other than wadeable streams: *Scartomyzon sp.* (brassy jumprock, abundant in larger

rivers including the Broad River), *Cyprinella nivea* (whitefin shiner, abundant in larger rivers) and *Fundulus lineolatus* (lined topminnow, abundant in swamps and wetlands).

Nine species were assigned priority status for the first time, including *N. chalybaeus* (Table 3). Seven previous priority species (Kohlsaat et al. 2005) scored outside the cutoff and were proposed for removal of priority status. However, three of these species—Ameiurus *catus* (white catfish)*, Carpiodes velifer* (highfin carpsucker) and *Carpiodes cyprinus* (quillback)— primarily occur in larger riverine habitats and therefore this assessment did not provide sufficient grounds to remove priority status for these species.

By family, the Cyprinidae produced the most priority species, followed by the Percidae and Catostomidae (Table 4). Within family, the highest proportion of priority species was exhibited by the Amblyopsidae, Anguillidae, Cottidae and Salmonidae, the lone species of each of which received priority status. Within families represented by more than one species, the highest proportions of priority species belonged to the Elassomatidae (75.0%), Percidae (69.2%) and Cyprinidae (65.8%).

Table 4.   Priority status by family for South Carolina stream fishes.

Family	Common Name	Native SC Stream species	Priority Species	Percent of All Priority	Percent of Family Priority
Amblyopsidae	Cavefishes	1	1	1.8	100.0
Anguillidae	Eels	1	1	1.8	100.0
Cottidae	Sculpins	1	1	1.8	100.0
Salmonidae	Trouts	1	1	1.8	100.0
Elassomatidae	Pygmy sunfishes	4	3	5.4	75.0
Percidae	Perches	13	9	16.1	69.2
Cyprinidae	Minnows	38	25	44.6	65.8
Lepisosteidae	Gars	2	1	1.8	50.0
Catostomidae	Suckers	14	6	10.7	42.9
Ictaluridae	Bullhead catfishes	11	4	7.1	36.4
Fundulidae	Topminnows	4	1	1.8	25.0
Centrarchidae	Sunfishes	15	3	5.4	20.0
Amiidae	Bowfins	1	0	0.0	0.0
Aphredoderidae	Pirate perches	1	0	0.0	0.0
Atherinidae	Silversides	2	0	0.0	0.0
Clupeidae	Herrings	1	0	0.0	0.0
Esocidae	Pikes	2	0	0.0	0.0
Poeciliidae	Livebearers	3	0	0.0	0.0
Soleidae	Soles	1	0	0.0	0.0
Umbridae	Mudminnows	1	0	0.0	0.0

Significant Deviations: None.

Model development and implementation.

Activity: Coordination with faculty at Clemson University Department of Forestry and Natural Resources and University of South Carolina Statistics Department is ongoing to analyze the StreamWeb database and develop suitable models which are intended for implementation in a decision support framework. During the reporting period, model development focused on priority fish species and general fish composition patterns in coastal plain streams. Results from clustering and ordination techniques indicated three to four typical associations of fishes occurring across the coastal plain landscape of South Carolina. Ongoing analysis centers on identifying the abiotic and landscape setting corresponding to the different associations, and whether predictive relationships can be developed.

Significant Deviations: None.

Estimated Federal Cost (grant level): $ (Federal expenditures to 30 September 2012)

Recommendations: Continue communication of stream resource status and model development, pursue publication in peer-reviewed literature.

Literature Cited

Branco, P., J. L. Costa and P. R. de Almeida. 2008. Conservation priority index for estuarine fish (COPIEF). Estuarine, Coastal and Shelf Science 80: 581-588.

Freitag, S. and A. S. Van Jaarsveld. 1997. Relative occupancy, endemism, taxonomic distinctiveness and vulnerability: prioritizing regional conservation actions. Biodiversity and Conservation 6: 211-232.

Jelks, H. L. et al. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. Fisheries 33(8): 372-407.

Kohlsaat, T., L. Quattro and J. Rinehart. 2005. South Carolina Comprehensive Wildlife Conservation Strategy 2005–2010. South Carolina Department of Natural Resources. url http://www.dnr.sc.gov/cwcs/index.html

Pritt, J. J. and E. A. Frimpong. 2010. Quantitative determination of rarity of freshwater fishes and implications for imperiled-species designations. Conservation Biology 24: 1249-1258.

Rohde, F. C., R. G. Arndt, J. W. Foltz and J. M. Quattro. 2009. Freshwater Fishes of South Carolina. The University of South Carolina Press, Columbia.

Scott, M.C. 2008. A probabilistic stream assessment to support freshwater conservation: preliminary results from the Coastal Plain. Proceedings of the 2008 South Carolina Water Resources Conference, Oct. 14-15, North Charleston.

South Carolina Department of Natural Resources. 2009. The South Carolina Stream Assessment Standard Operating Procedures. Version 2009. Freshwater Fisheries Section.

Warren, M. L. et al. 2000. Diversity, distribution, and conservation status of the native freshwater fishes of the southern United States. Fisheries 25(10): 7-31.