Possible Procedure to set DO Criteria for Newly Classified Streams

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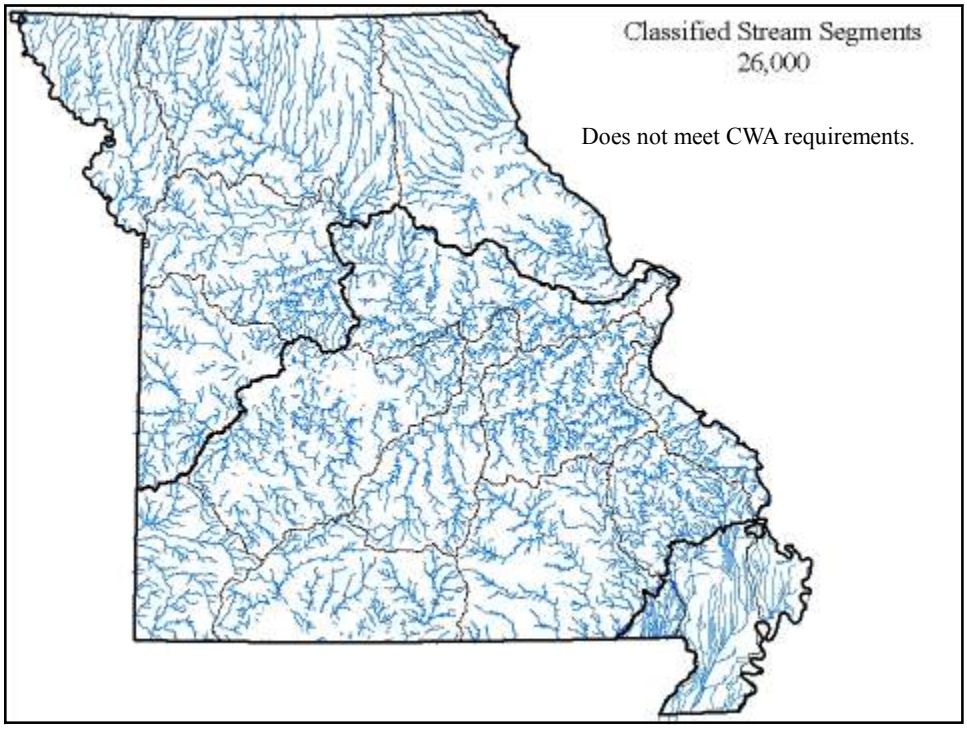
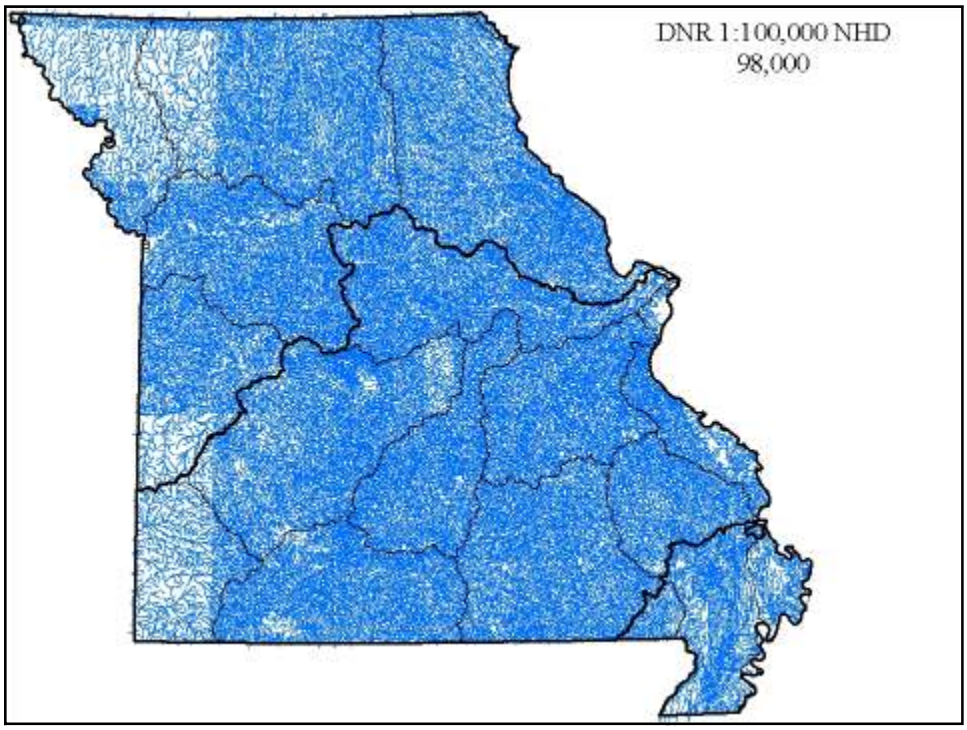
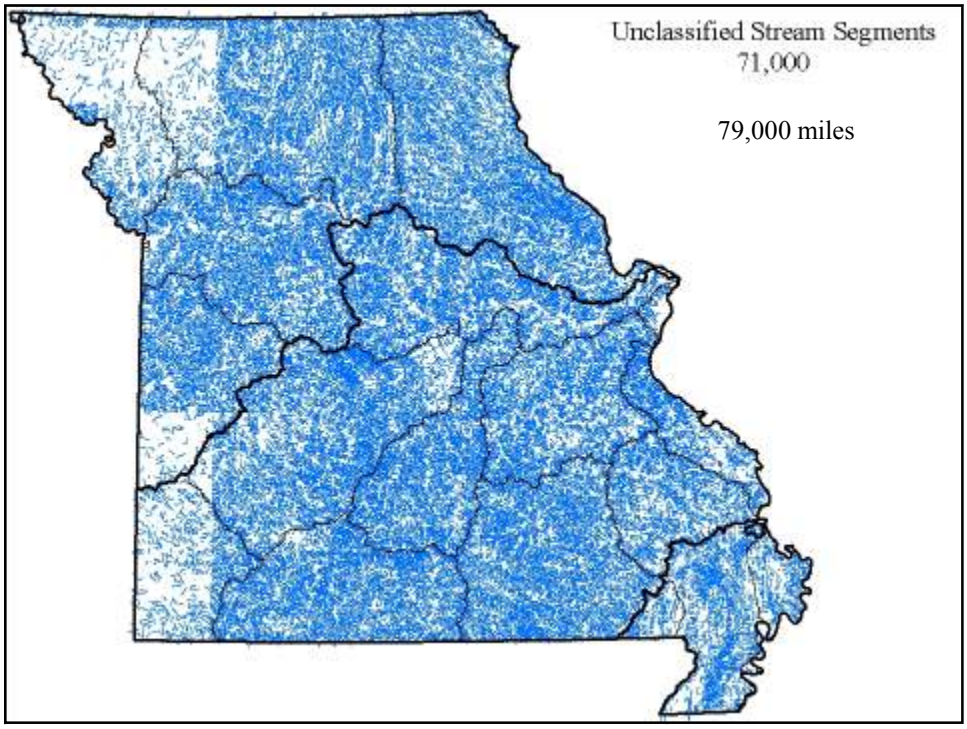
Classified Streams

- Anti-degradation
- Must support aquatic life
- Meet water quality criteria:
  - Current standards (5.0 mg/L DO)
  - OR develop appropriate standards


Classified Stream Segments
26,000
Does not meet CWA requirements.


DNR 1:100,000 NHD
98,000



"Do they even have any life in them to protect?"

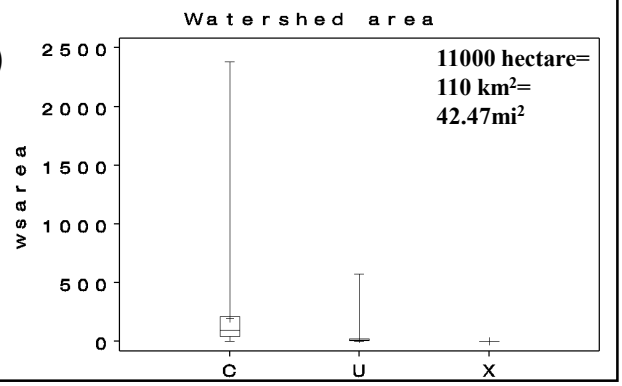
Characteristics of Unclassified Sites (Watershed)

- Mean watershed area (km^2)

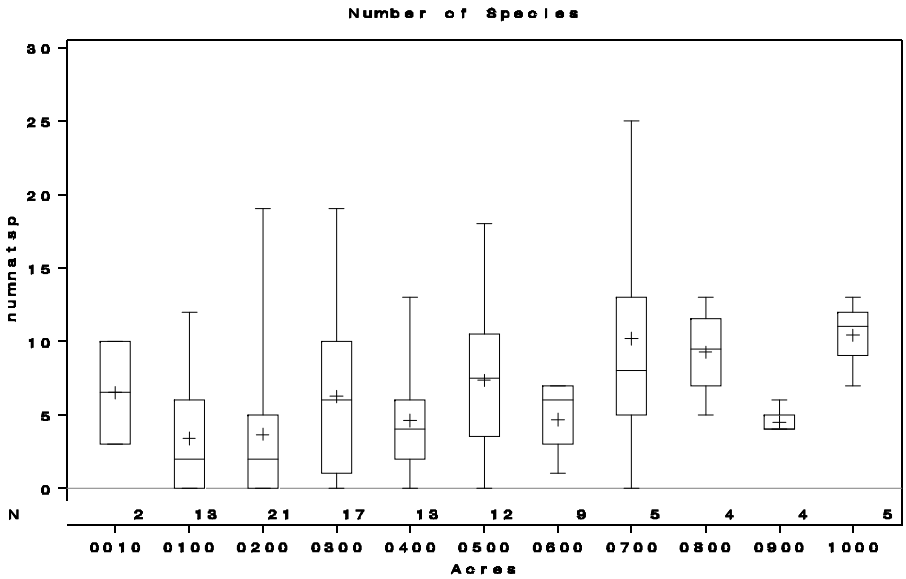
  C = 196 (0.73 - 2382)

  U = 23 (0.44 - 578)

  X = 0.62 (0.03 - 1.5)

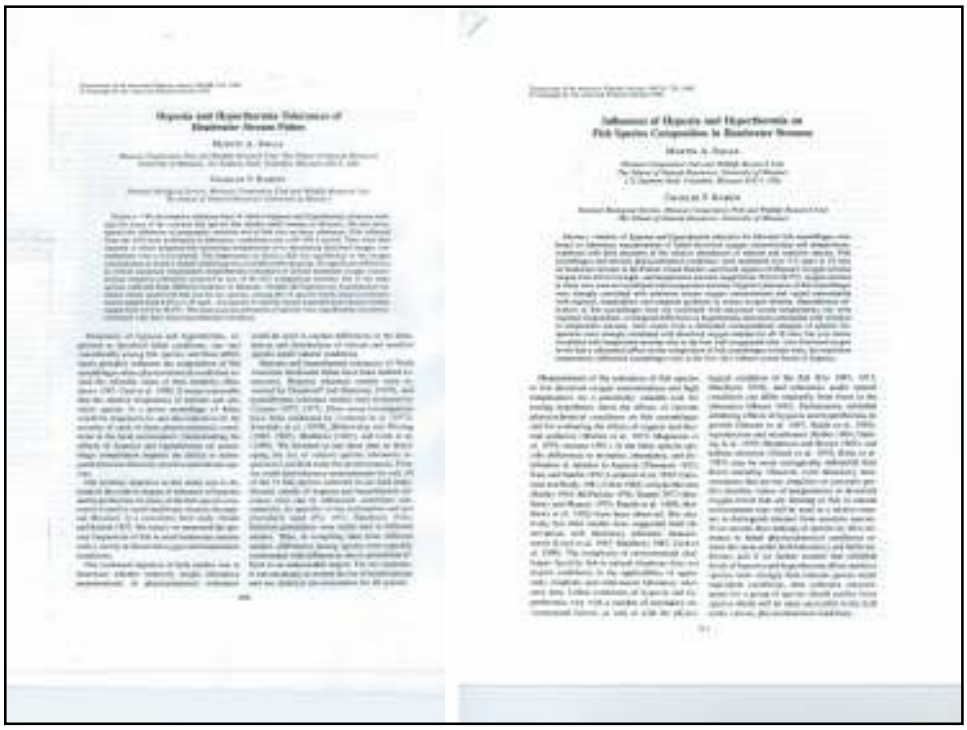


Fish



Isn't DO naturally lower in these small headwater streams?

OK, so they have fishes. But do those fishes need 5 mg/L O_2 to thrive?



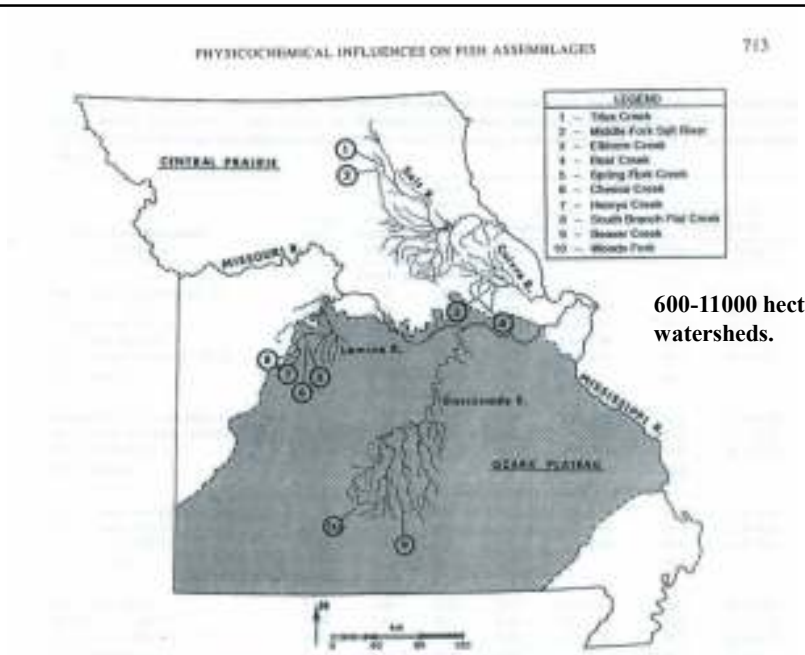


FIGURE 1.—Locations of the study streams and their drainage basins in Missouri. The boundary for the Ozark region (shaded area) is taken from MDNR (1986), and sites in both the Ozark and Ozark Border groups in this study are encompassed by this boundary.

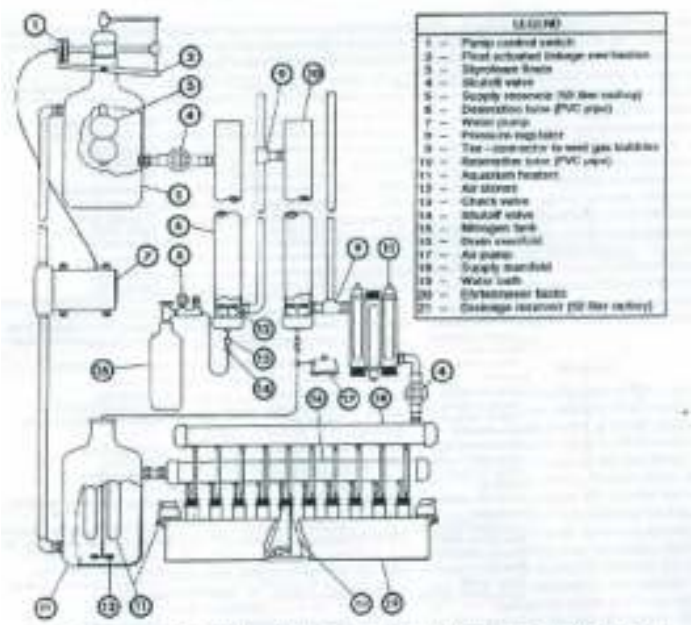


FIGURE 1.—Diagram of the apparatus used for testing hypoxia and hyperkinesia tolerances; PVC is polyvinyl chloride. The drawing is not to scale and the relative positions of parts of the apparatus are approximate.

TABLE 2.—Sample sizes, ranges of weights, and hypoxia tolerances for 35 species of Missouri fish. The test column indicates those species for which tolerances of fish from two populations (P) were compared or relationships between tolerances and fish weight (W) were analyzed. The ranks of those species whose hypoxia tolerances differed significantly (Tukey's honestly significant difference test, $P \leq 0.05$) from the species in each row are listed in the last two columns. The average mean tolerance over 35 species was 0.93 mg/L.

Species	Rank	Test	N	Range of weights (g)	Critical dissolved oxygen concentration (mg/L): Mean	SD	95% confidence interval	Ranks of species that were significantly: More tolerant	Less tolerant
Brook silversides	1		9	0.6–2.4	1.55	0.14	1.39–1.48	4–36	
Rosyface shiner	2		6	1.4–3.1	1.49	0.16	1.67–1.31	5–36	
Ozark minnow	3	W	13	0.4–3.1	1.45	0.20	1.57–1.33	5–36	
Bleeding shiner	4	W	7	0.7–5.1	1.35	0.13	1.47–1.23	6–36	1
Smallmouth bass	5	W	10	2.6–9.6	1.19	0.14	1.29–1.08	17–36	1–3
Redfin shiner	6	W	9	0.4–2.2	1.17	0.11	1.25–1.08	18–36	1–3
Black bullhead	7		7	1.1–3.3	1.12	0.15	1.27–1.00	24–36	1–3
Rainbow darter	8	W	10	0.4–2.6	1.10	0.15	1.21–0.99	24–36	1–4
Hornyhead chub	9	W	8	2.0–12.2	1.06	0.17	1.20–0.92	27–36	1–4
Bluntnose minnow	10	P, W	14	0.6–4.8	1.04	0.12	1.11–0.97	27–36	1–4
Suckermouth minnow	11		7	1.1–3.6	1.04	0.02	1.09–0.98	27, 29–36	1–3
Striped shiner	12	W	13	1.1–10.5	1.03	0.12	1.10–0.95	27–36	1–4
Bigmouth shiner	13	W	12	0.2–2.9	1.02	0.08	1.07–0.97	27–36	1–4
Largemouth bass[a]	14	P, W	12	3.0–12.9	1.01	0.15	1.10–0.91	27–36	1–4
Fantail darter	15		9	0.2–0.8	0.98	0.10	1.06–0.91	27–36	1–4
White sucker	16		3	3.4–9.2	0.98	0.08	1.16–0.79	34–36	1–4
Common shiner	17	P, W	14	2.0–9.6	0.97	0.14	1.06–0.89	27–36	1–5
Central stoneroller	18	P, W	12	0.3–5.8	0.95	0.14	1.06–0.86	27–36	1–6
Sand shiner	19		6	0.9–1.5	0.93	0.17	1.11–0.75	32–36	1–5
Plains topminnow	20		7	0.5–2.2	0.92	0.11	1.02–0.82	32–36	1–6
Red shiner	21	W	12	0.2–3.1	0.91	0.13	0.99–0.82	32–36	1–6
Blackspotted topminnow	22		4	0.6–2.2	0.88	0.23	1.25–0.51	36	1–6
Blackstripe topminnow	23	W	8	0.4–3.1	0.88	0.03	0.90–0.85	34–36	1–8
Orangethroat darter	24		8	0.4–4.2	0.86	0.15	0.98–0.73	34–36	1–8
Creek chub	25	W	10	1.0–10.1	0.84	0.08	0.90–0.79	34–36	1–8
Southern redbelly dace	26	W	19	0.3–2.6	0.74	0.11	0.80–0.69	36	1–15, 17–18
Fathead minnow	27	W	12	0.4–4.5	0.73	0.10	0.79–0.67	36	1–15, 17–18
Johnny darter	28		7	0.5–2.3	0.70	0.07	0.76–0.64		1–15, 17–18
Golden shiner	29	W	9	1.0–9.4	0.70	0.07	0.75–0.65	36	1–15, 17–18
Largemouth bass[b]	30	P, W	7	5.5–25.5	0.70	0.06	0.77–0.63		1–15, 17–18
Longear sunfish	31	W	11	0.7–22.4	0.68	0.09	0.74–0.63		1–15, 17–22
Bluegill	32		7	1.2–23.6	0.66	0.09	0.74–0.57		1–15, 17–22
Green sunfish	33	P, W	13	0.6–29.8	0.63	0.10	0.68–0.57		1–22, 24–26
Orangespotted sunfish	34	W	10	0.9–6.6	0.62	0.08	0.68–0.56		1–22, 24–28
Slender madtom	35	W	11	1.1–8.5	0.60	0.10	0.67–0.54		1–22, 24–28
Yellow bullhead	36	W	11	2.5–23.9	0.49	0.08	0.55–0.46		1–28, 30

[a] Wisconsin hatchery sample. [b] Missouri stream sample.

FISHNAME	DO	AccuteDO	ChronicDO
BROOK SILVERSIDES	1.70	2.04	4.08
ROSYFACE SHINER	1.67	2.00	4.01
OZARK MINNOW	1.57	1.88	3.77
BLEEDING SHINER	1.47	1.76	3.53
SMALLMOUTH BASS	1.29	1.55	3.10
REDFIN SHINER	1.25	1.50	3.00
BLACK BULLHEAD	1.27	1.52	3.05
RAINBOW DARTER	1.21	1.45	2.90
HORNYHEAD CHUB	1.20	1.44	2.88
BLUNTNOSE MINNOW	1.11	1.33	2.66
SUCKERMOUTH MINNOW	1.09	1.31	2.62
STRIPED SHINER	1.10	1.32	2.64
BIGMOUTH SHINER	1.07	1.28	2.57
FANTAIL DARTER	1.06	1.27	2.54
WHITE SUCKER	1.16	1.39	2.78
COMMON SHINER	1.06	1.27	2.54
CENTRAL STONEROLLER	1.04	1.25	2.50
SAND SHINER	1.11	1.33	2.66
PLAINS TOPMINNOW	1.02	1.22	2.45
RED SHINER	0.99	1.19	2.38
BLACKSPOTTED TOPMINNOW	1.25	1.50	3.00
BLACKSTRIPE TOPMINNOW	0.90	1.08	2.16
ORANGETHROAT DARTER	0.98	1.18	2.35
CREEK CHUB	0.90	1.08	2.16
SOUTHERN REDBELLY DACE	0.80	0.96	1.92
FATHEAD MINNOW	0.79	0.95	1.90
JOHNNY DARTER	0.76	0.91	1.82
GOLDEN SHINER	0.75	0.90	1.80
LARGEMOUTH BASS	0.77	0.92	1.85
LONGEAR SUNFISH	0.74	0.89	1.78
BLUEGILL	0.74	0.89	1.78
GREEN SUNFISH	0.68	0.82	1.63
ORANGESPOTTED SUNFISH	0.68	0.82	1.63
SLENDER MADTOM	0.67	0.80	1.61
YELLOW BULLHEAD	0.52	0.62	1.25

Acute DO = UpperDO*1.2 mg/L

Chronic DO = UpperDO*2*1.2 mg/L

Similar to: USEPA. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection Of Aquatic Organisms and Their Uses.

Northern studfish and Ozark sculpin present, but did not survive acclimation to DO tolerance tests.

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WHITE SUCKER	1.16	1.39	2.78
COMMON SHINER	1.06	1.27	2.54
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SAND SHINER	1.11	1.33	2.66
PLAINS TOPMINNOW	1.02	1.22	2.45
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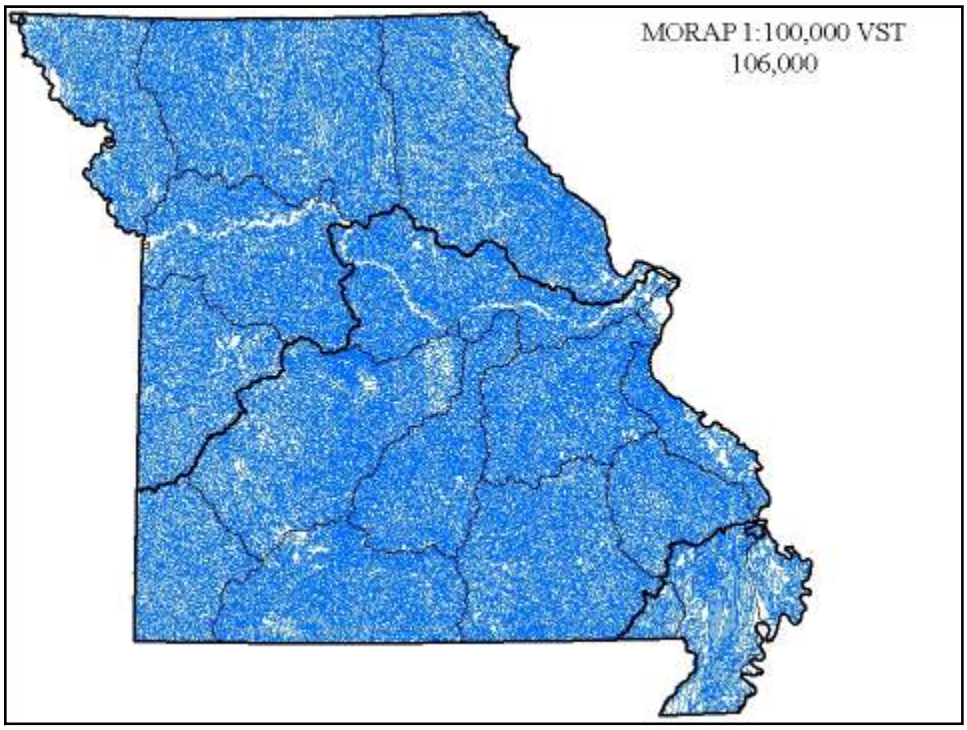
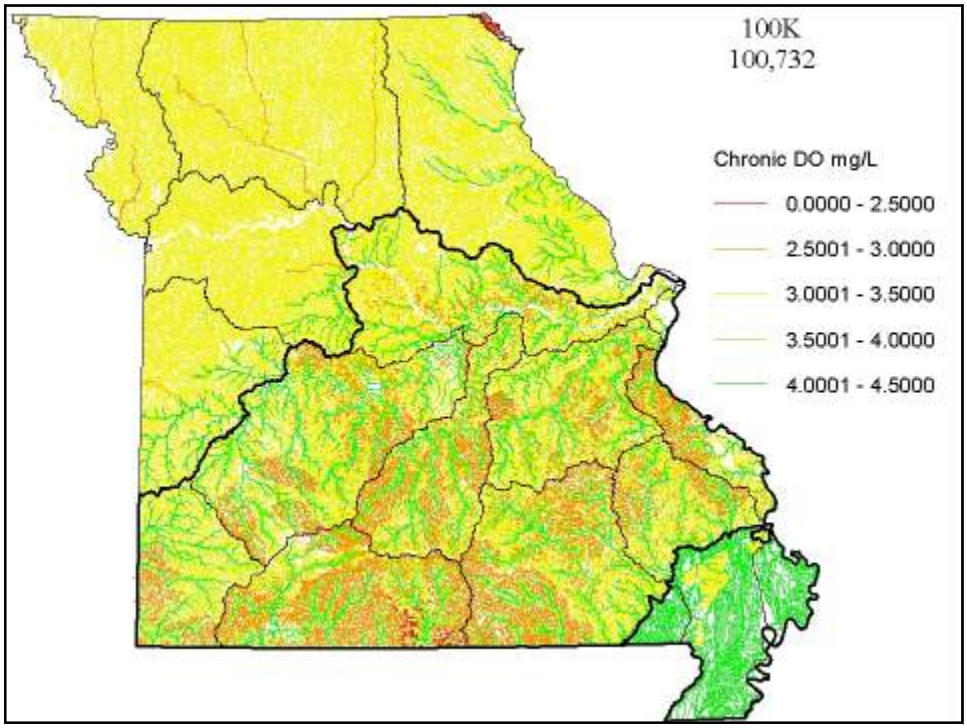
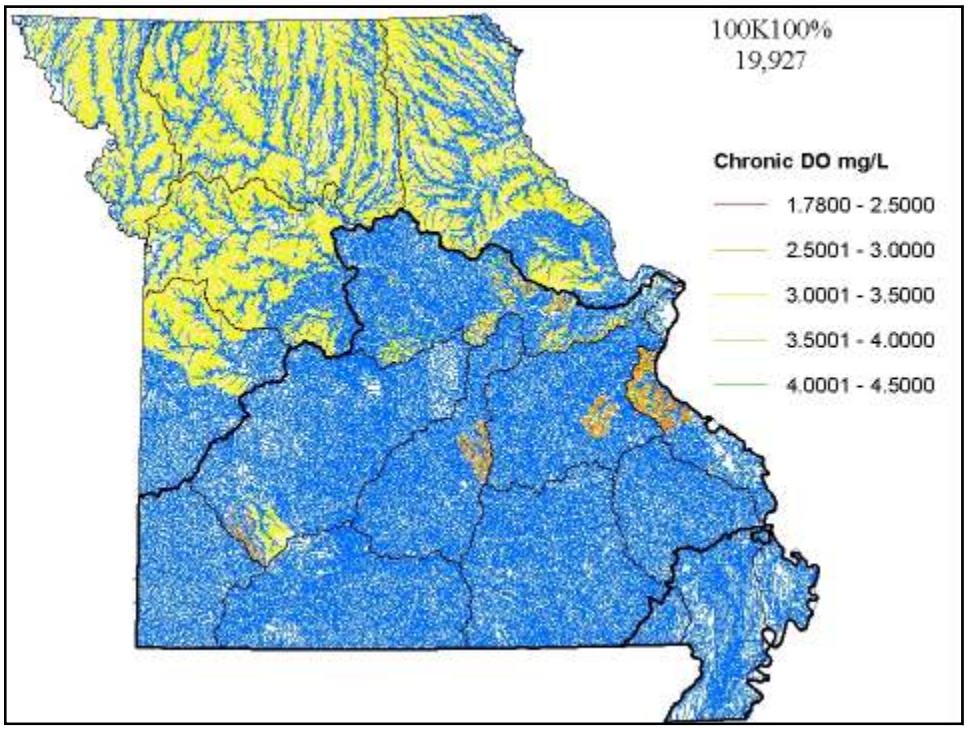
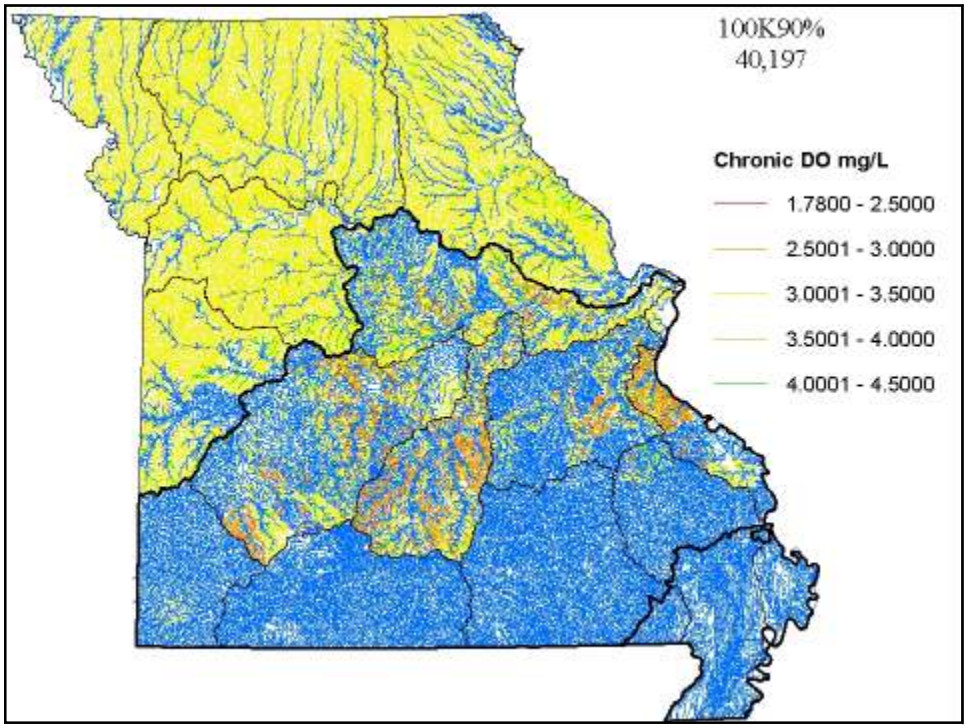
ORANGETHROAT DARTER	0.98	1.18	2.35
CREEK CHUB	0.90	1.08	2.16
SOUTHERN REDBELLY DACE	0.80	0.96	1.92
FATHEAD MINNOW	0.79	0.95	1.90
JOHNNY DARTER	0.76	0.91	1.82
GOLDEN SHINER	0.75	0.90	1.80
LARGEMOUTH BASS	0.77	0.92	1.85
LONGEAR SUNFISH	0.74	0.89	1.78
BLUEGILL	0.74	0.89	1.78
GREEN SUNFISH	0.68	0.82	1.63
ORANGESPOTTED SUNFISH	0.68	0.82	1.63
SLENDER MADTOM	0.67	0.80	1.61
YELLOW BULLHEAD	0.52	0.62	1.25

Joined Chronic DO value to predicted species list for all segments on the MORAP 1:100,00 VST. Selected most sensitive species value as criteria for the segment. Thus each segments DO criteria is the most sensitive community members' critical minimum dissolved oxygen concentration times 2 plus 20%.



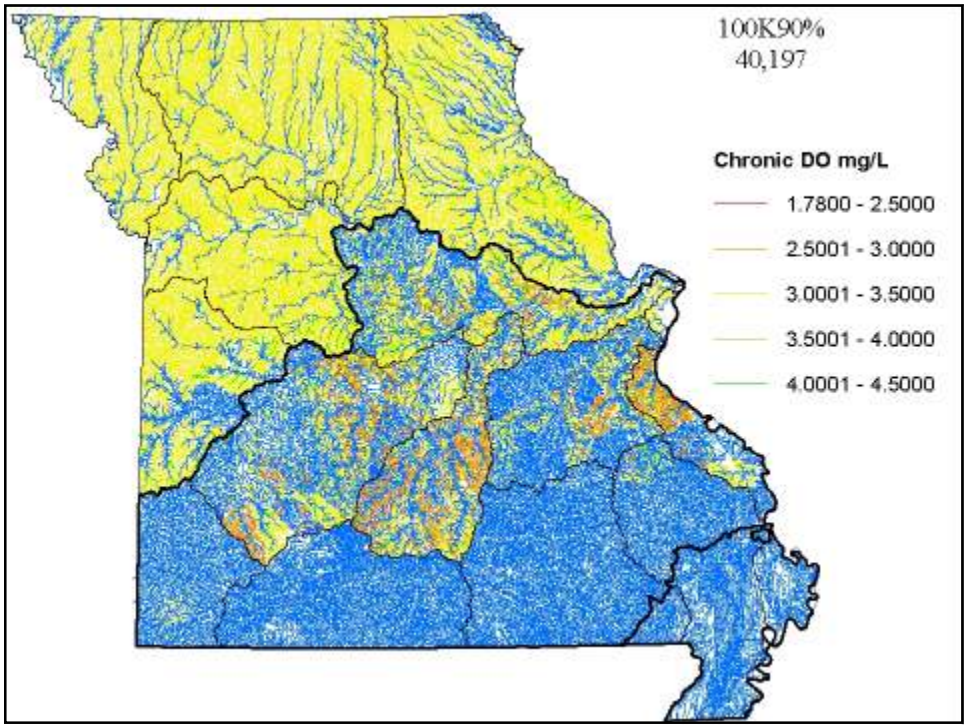

100K
100,732
Chronic DO mg/L
0.0000 - 2.5000
2.5001 - 3.0000
3.0001 - 3.5000
3.5001 - 4.0000
4.0001 - 4.5000


100K100%
19,927
Chronic DO mg/L
1.7800 - 2.5000
2.5001 - 3.0000
3.0001 - 3.5000
3.5001 - 4.0000
4.0001 - 4.5000



Conclusions

- This method allows the criteria to match the predicted fish communities DO needs.
- It could be applied statewide by testing other species.
- It should only be applied to segments where >90% of the predicted community has been tested.


100K90%
40,197
Chronic DO mg/L
1.7800 - 2.5000
2.5001 - 3.0000
3.0001 - 3.5000
3.5001 - 4.0000
4.0001 - 4.5000