State Wildlife Grant Final Report

Status and critical habitat of special concern and rare fish species in lakes within seven counties in Minnesota.

Konrad Schmidt (Nongame Fish Program)
Nick Proulx (Biocriteria Development Program)
Minnesota Department of Natural Resources
Division of Ecological Resources
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Least Darter

Pugnose Shiner

Longear Sunfish

Abstract

A total of 125 lakes were sampled in 7 counties from 2006-2008 based on criteria of water transparency, intolerant species associates and historical occurrences of targeted species: least darters *(Etheostoma microperca)*, pugnose shiners *(Notropis anogenus)* and longear sunfish *(Lepomis megalotis).* Least darters were found in 49 lakes (44 new localities), pugnose shiners in 30 (20 new) and longear sunfish in 2. Noteworthy results include least darters in Lake Minnewashta (Carver County) where the species was last reported in 1962 and the first record of the species from the St. Croix River Drainage in Forest Lake (Washington County). Pugnose shiners were found in Thompson Lake (Sherburne County) where they have not been reported since 1959 and Clearwater Lake (Wright County) since 1946.

Introduction

The Minnesota Department of Natural Resources designated the least darter and pugnose shiner special concern species in 1984. Historical data indicated both species had very limited distribution and never abundant at known localities. Both species are restricted to crystal, clear lakes and low gradient (sluggish) streams with dense submergent vegetation. The least darter is most often found in large, dense beds of muskgrass *(Chara sp.)* while the pugnose shiner prefers a more diverse community of pondweeds (*Potamogeton sp.* and *Najas sp.)* and eelgrass *(Vallisneria sp.)*; however, muskgrass is almost always a dominant species (Figure 1).

Figure 1. Muskgrass bed (foreground) in Lower Spunk Lake - Stearns County.

Both fishes inhabit lakes and streams of exceptionally high water quality and function as indicators of environmental health. When light transparency is diminished due to nutrient enrichment or turbidity, submergent vegetation and habitat for both species, is compromised and eventually eliminated if conditions do not improve. Absence is always much more difficult to prove than presence and many historical occurrences of these species may have disappeared unnoticed due to a lack of statewide surveys prior to the 1940s. Nevertheless, one *known* extirpation of the least darter has occurred in Crystal Lake (Hennepin County), where it was last reported in 1931 and the pugnose shiner is no longer found in at least 11 lakes (Table 1).

Table 1. Known extirpations of the pugnose shiner in Minnesota. The list includes each lake's DNR Division of Waters number (DOW#), water clarity at the last DNR Fisheries survey and the last year the species was reported.

DOW#	Lake	County	Water Clarity (Feet)	Last Report
10005900	Waconia	Carver	5.5 (2006)	1948
27013700	Christmas	Hennepin	20.0 (2007)	1940
27011800	Fish	Hennepin	2.7 (2003)	1948
27001600	Harriet	Hennepin	9.5 (2005)	1948
47004600	Washington	Meeker	3.9 (2004)	1947
61014900	Mountain	Pope	13.0 (2004)	1963
62005400	McCarron	Ramsey	8.4 (2003)	1931
73005500	Grand	Stearns	4.0 (1998)	1949
81000300	St. Olaf	Waseca	4.0 (2006)	1954
82015900	Forest	Washington	6.3 (2005)	1941
86019900	Howard	Wright	5.8 (2006)	1946

The longear sunfish is a Species in the Greatest Conservation Need (SGCN) and had not been reported in Minnesota until 1974 from Hustler Lake (St. Louis County). Since then, a number of new localities have been found, but the species distribution in the state remains extremely spotty. Like the least darter and the pugnose shiner, longear sunfish are restricted to lakes with high transparencies and dense submergent vegetation.

Methods and Materials

Criteria used in lake selection included (1) historical occurrences of one or more of the three targeted species and other lakes in the same watersheds accessible via stream connections, (2) water transparencies greater than six feet and (3) the presence of other intolerant species typically associated with the targeted species: blackchin shiner *(Notropis heterodon)*, blacknose shiner *(Notropis heterolepis)* and banded killifish *(Fundulus diaphanus)*.

Standardized surveys: The Index of Biotic Integrity (IBI) is a tool in which biological communities are used to determine the relative health of an aquatic system. For this grant, fish community information was collected from a subset of the targeted lakes. Game fish surveys performed by DNR Fisheries coupled with this State Wildlife Grant's near shore nongame fish sampling, were used to describe the fish community composition and provided inputs to the lake IBI developed by Drake et al (2002, 2005). Specifically, fish survey information is placed into categories or metrics that represent certain aspects of the fish community that statistically relate to habitat condition. These metrics, once validated, are used to score a lake, with scores ranging from 0 (no fish) to 160 (exceptional).

The protocol is divided by game fish surveys and near shore surveys. The game fish surveys include gill and trap net data designed to estimate game fish populations and abundance. The near shore surveys are designed to determine presence of near shore fish species using backpack electrofishing and seining on 10 equally distant stations, 30 meters in length and selected randomly. In addition to fish sampling, various habitat measures were completed including, riparian land use; and aquatic plant presence, bio-volume and relative abundance.

Non-standardized surveys: These survey methods were used to greatly increase the number of lakes sampled for the three targeted species. IBI surveys required one day for each lake while the non-standardized surveys sampled 6-10 lakes per day. Generally, seines were more effective on pugnose shiners while dip nets were the gear of choice for least darters. The seines were attached to brails and bag-less (length: 3.7 m, depth: 1.8 m and mesh: 3.2 mm). Dip or kick nets resembled an angler's landing net but the mesh size ranged from 1.6 to 3.2 mm and the handles telescoped from 102 to 203 cm. Surveys of most lakes were restricted to public water accesses. However, when these efforts produced a new occurrence for the least darter or pugnose shiner, a few lakes were revisited with a boat to survey additional preferred habitats along the shoreline for the "other" targeted species.

Where depths and substrates permitted, the seine was used first. To avoid disturbing vegetation, seiners waded down boat ramps to a depth of about 1 m. One end of the seine was inserted into the line of submergent vegetation along the ramp to clip the outer 0.5-1 m of the edge. As the seine was dragged shoreward, the vegetation was kicked outward and the ramp side was kept a few feet ahead while that seiner constantly used a free hand to splash the surface of the water. This disturbance helped herd and corral fish back inside the pocket of the seine. In dense beds of vegetation, the seine was "threaded" to form a pocket and fish were flushed from cover as seiners kicked the vegetation from both sides back toward the seine before lifting. In moderate vegetation, seines were dragged, but kept off the bottom to clip the top of the canopy. Both seiners hand splashed the surface to turn fleeing schools of minnows back into the pocket. At the end of the haul, both seiners turned around to kick vegetation toward the seine.

Dip nets were used in wadeable depths, but also from a boat to about 2 m. In shallow water, the most common method used for the dip net was holding it out from either side of the netter while wading a line through several meters of a muskgrass bed. One hand grasped the end of the handle and other placed a comfortable distance toward the sock to serve as a brace. The top of the canopy would be "raked" dislodging fish from cover and functioned similar to a much larger bottom trawl. In extremely dense muskgrass, the dip net frame encountered too great a resistance or caused the sock to roll up. In these instances, the sock was inserted into empty pockets within the muskgrass and pulled to the edge. The netter would then kick the vegetation toward the sock and lift. In many lakes, muskgrass beds would begin at the maximum wadeable depth. This would require extending the dip net handle and swing it overhead toward deeper water, allow the sock to sink and rake the vegetation back toward the netter (Figure 2).

Although never collected in large numbers, pugnose shiners could be effectively sampled on sunny days scooping schools near the water's surface. As the netter slowly walked through vegetation, the dip net would be "cocked" on one side with one hand at the end of handle and the yoke of the net cupped in the other. When fleeing schools were sighted, the net would be "shot"

Figure 2. Dip netting deeper habitat.

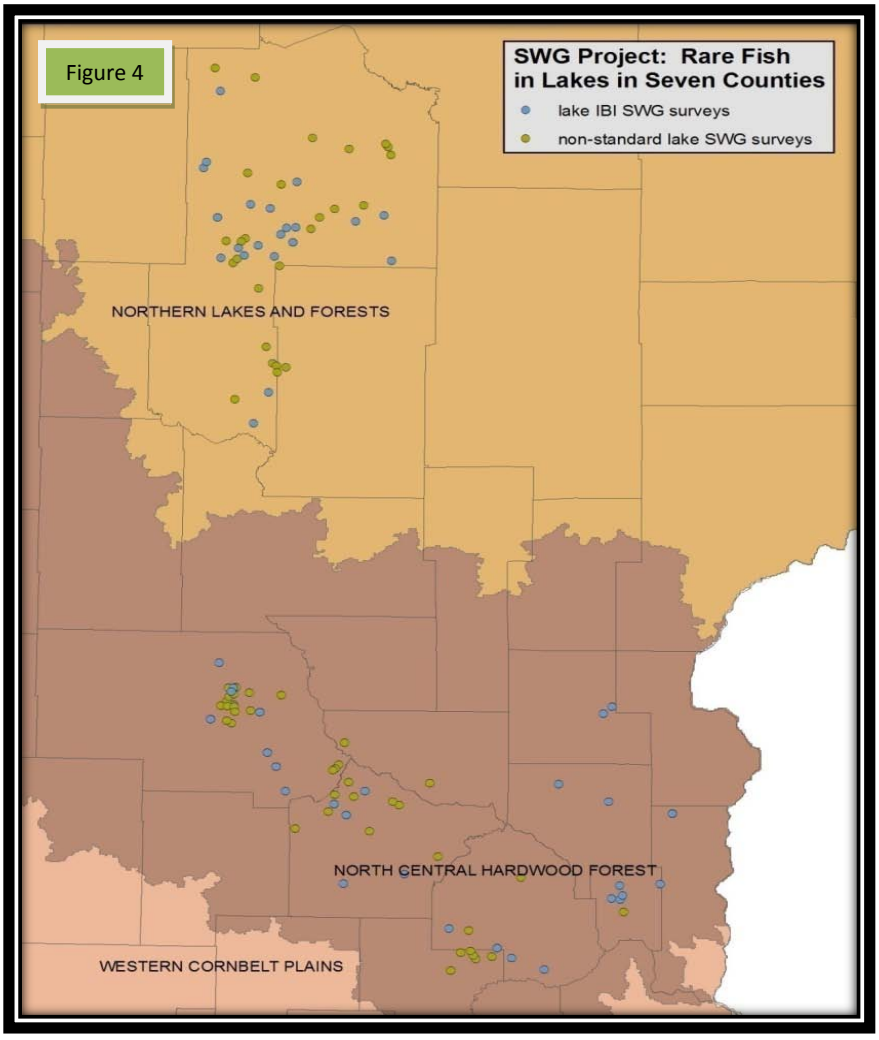
Figure 3. Scooping schools of minnows.

in a continuous and rapid motion at a shallow angle under the fish and scooped out of the water (Figure 3). In deeper water using a boat, dip net handles were fully extended and deployed off the side. The net was "locked" in place with one hand grasping the handle's butt and netter's leg and foot bracing the back of the handle. The boat operator would then slowly "troll" muskgrass beds following the netters instructions for more or less speed. The scooping method was also used from the boat with the netter kneeling on the bow while trolling along vegetation edges.

Data recorded included counts of least darters and pugnose shiners, GPS coordinates and presence of species associates. Up to 10 specimens of the two targeted species were preserved in 10% formalin for museum collections at the James Ford Bell Museum of Natural History in St. Paul, MN or the Indiana Biological Survey in Bloomington, IN. Occurrences of both special concern species were provided to the Minnesota Natural History Program for data entry.

Results and Discussion

From 2006-2008, 125 lakes were surveyed and included 48 lakes utilizing standardized Index of Biotic Integrity (IBI) protocols and non-standardized surveys of 77 lakes targeting the three species and their habitats (Figure 4).



The IBI surveys sampled 48 lakes and found least darters in 16 lakes (11 new localities), pugnose in 14 (6 new) and longear sunfish in 2 (Table 2 and Appendix 1).

Table 2. Standardized IBI survey results (location, dates, species numbers and IBI score. New localities are indicated with an asterisk (*) following the lake name. Lakes in **bold** indicate additional sampling with non-standardized methods (Table 3).

DOW#	Lake Name	County	Least Darter	Pugnose Shiner	Longear Sunfish	Date	Acres	Water Clarity (feet)	IBI Score Maximum 160	Latitude	Longitude
02004200	Coon	Anoka				6/25/2007	1259	7.8	59	45.30549	-93.16643
02009100	George*	Anoka	12			7/2/2008	495	13.8	97	45.35670	-93.33548
11005300	Lawrence	Cass	1			7/27/2006	215	10.0	95	46.82137	-93.92894
11006200	Big Thunder	Cass			2	7/15/2008	1347	16.5	131	46.95272	-93.97407
11011400	Mitten	Cass				8/1/2007	117	7.0	67	46.93090	-94.06262
11017700	Three Island	Cass				6/24/2008	288	10.0	63	47.04047	-94.26904
11019900	**Hay**	Cass		4		7/25/2006	350	12.0	101	46.86969	-94.28108
11020000	Mule	Cass				8/23/2006	524	16.0	95	46.91276	-94.26710
11025000	Ada	Cass				7/31/2007	1044	15.0	105	46.82979	-94.34950
11025700	Island	Cass				8/2/2007	173	17.5	96	46.89166	-94.32642
11027400	Blackwater*	Cass	6	15		6/28/2006	765	14.0	118	46.90866	-94.30490
11028300	Baby	Cass	14		9	7/26/2006	722	10.0	140	46.96415	-94.36402
11030400	Sylvan*	Cass	3			7/14/2008	803	20.5	123	46.36551	-94.40000
11030500	Gull	Cass				8/20/2007	9418	13.0	116	46.44626	-94.35107
11030800	Big Portage*	Cass		4		8/1/2007	918	7.2	98	46.85452	-94.42372
11035800	Horseshoe	Cass				7/26/2006	258	11.0	103	46.85160	-94.47424
11036100	Sanborn	Cass				8/23/2006	209	14.0	124	46.83144	-94.45398
11038700	Little Webb	Cass				6/25/2008	226	>12	67	46.97395	-94.43333
11041100	Pine Mountain	Cass				7/30/2007	1558	6.1	111	46.82372	-94.53312
11041200	**Birch***	Cass	2			6/23/2008	1284	7.7	90	46.93846	-94.54518
11048000	Long*	Cass	1	11		6/27/2006	284	10.0	115	47.07372	-94.60209
11048200	May*	Cass		25		6/28/2006	143	14.0	117	47.09049	-94.59325
11048800	Thirteen*	Cass		18		6/23/2008	470	10.0	105	47.29124	-94.54942
27004700	Bush	Hennepin				6/22/2007	172	16.8	61	44.83670	-93.38303
27007100	Round	Hennepin				6/15/2006	31	14.0	62	44.86839	-93.49286
27013700	**Christmas**	Hennepin	44			5/30/2006	257	19.0	86	44.89699	-93.54333
27017900	**North Little Long***	Hennepin	1			8/16/2006	108	15.0	93	44.94960	-93.70820
30002200	Skogman	Isanti				7/2/2006	221	4.0	43	45.57396	-93.15225
30004300	Fannie	Isanti				7/11/2006	347	6.0	61	45.55532	-93.18638
62005600	Owasso	Ramsey				7/7/2006	358	7.0	85	45.03514	-93.12235
62005700	Josephine	Ramsey				6/6/2006	105	7.0	61	45.03574	-93.15323
62007300	Snail	Ramsey				6/7/2006	150	9.0	64	45.07325	-93.12606
62008200	Wabasso	Ramsey				9/15/2006	46	13.0	57	45.04489	-93.11577
73003500	School Section	Stearns				8/18/2008	188	9.0	44	45.33025	-94.27205
73003700	**Pearl**	Stearns				7/17/2008	733	3.7	96	45.39900	-94.30635
73005500	**Grand**	Stearns				8/19/2008	655	4.0	115	45.43683	-94.33691
73006400	**Kraemer**	Stearns				8/8/2007	194	12.3	90	45.55083	-94.36527
73012300	**Lower Spunk**	Stearns	21	5		9/10/2008	280	7.5	112	45.61735	-94.45852
73012800	**Middle Spunk**	Stearns		1		8/20/2008	236	10.0	93	45.60686	-94.46535
73013800	Two Rivers	Stearns				7/16/2008	575	5.2	55	45.68413	-94.50604
73017200	Clear	Stearns				8/1/2006	113	7.0	67	45.52900	-94.53472
82015900	**Forest**	Washington				5/30/2007	2251	6.3	108	45.27359	-92.94888
82016700	White Bear*	Washington	2			7/9/2008	2416	15.5	93	45.07719	-92.98404
86004600	Crawford	Wright				8/27/2007	109	14.0	41	45.10155	-93.86007
86016300	Limestone*	Wright	7	8		9/10/2008	188	8.3	116	45.33355	-93.99902
86019900	Howard	Wright				7/6/2006	736	4.0	50	45.07218	-94.06914
86022700	**Cedar**	Wright	11			6/14/2006	783	7.0	61	45.26929	-94.06463
86025200	Clearwater*	Wright	8	7		7/15/2008	3158	7.4	96	45.29537	-94.10497

The non-standardized surveys sampled 77 lakes (Table 3 and Appendix 2) and found least darters in 33 lakes (23 new localities) and pugnose shiners in 16 (14 new).

Table 3. Non-standardized survey results (locations, dates, species numbers and gear). New localities are indicated with an asterisk (*) following the lake name. Lakes in **bold** indicate additional sampling with standardized IBI survey (Table 2).

DOW#	Lake	County	Least Darter	Pugnose Shiner	Date	Sampling Gear	Acres	Water Clarity (feet)	Latitude	Longitude
10000900	Minnewashta	Carver	21		5/5/2006	Seine	667	4.3	44.86470	-93.61480
10001100	St. Joe	Carver			5/5/06	Dip Net/Seine	14	10.0	44.87458	-93.62298
10001200	Ann	Carver			5/16/06	Seine	110	5.5	44.87111	-93.55991
10001500	Virginia	Carver			5/5/06	Dip Net/Seine	110	10.5	44.88585	-93.63299
10004100	Zumbra	Carver	11		5/16/2006	Dip Net/Seine	162	7.3	44.88270	-93.66710
10005300	Pierson	Carver			5/5/06	Dip Net/Seine	297	8.5	44.83257	-93.69823
11008200	Cedar	Cass			8/19/2008	Dip Net	19	15.0	47.14094	-93.95140
11008600	Graves*	Cass	25		8/19/2008	Dip Net/Seine	377	17.0	47.11790	-93.94090
11009400	Tidd	Cass			8/19/2008	Dip Net	60	12.0	47.14797	-93.95952
11010500	Upper Trelipe*	Cass	28		8/20/2008	Dip Net/Seine	409	8.0	46.97590	-94.03510
11012000	Inguadona	Cass			8/20/2008	Dip Net/Seine	1125	10.0	46.96303	-94.13179
11014300	Boy	Cass			8/19/2008	Dip Net/Seine	3186	5.5	47.10552	-94.14724
11016700	Little Boy*	Cass		11	8/20/2008	Dip Net	1372	5.0	46.94110	-94.18940
11017100	Wabedo*	Cass	7	1	8/20/2008	Dip Net	1185	5.3	46.90790	-94.21960
11019900	**Hay**	Cass			8/22/2007	Dip Net	364	16.0	46.86969	-94.28108
11020300	Leech	Cass			8/18/2008	Dip Net/Seine	102948	9.0	47.16226	-94.40534
11021800	Upper Gull*	Cass	4		8/21/2007	Dip Net	423	7.5	46.52990	-94.34500
11022000	Ray*	Cass	3	1	8/21/2007	Dip Net	136	12.0	46.52220	-94.33110
11022600	Loon	Cass			8/21/2007	Dip Net/Seine	235	8.5	46.57525	-94.36740
11028900	Cedar*	Cass		20	8/18/2008	Dip Net	141	12.3	47.03220	-94.32580
11030700	Norway	Cass			8/20/2007	Dip Net/Seine	524	7.0	46.73844	-94.39731
11031300	Lower Sucker	Cass			8/19/2008	Dip Net/Seine	585	7.0	47.32917	-94.42564
11032400	Rock	Cass			8/20/2007	Dip Net/Seine	240	3.5	46.42649	-94.47458
11035000	Bowen	Cass			8/21/2007	Dip Net/Seine	176	3-6	46.81043	-94.49095
11035100	Five Point	Cass			8/22/2007	Dip Net/Seine	219	6.0	46.87965	-94.44838
11035300	Beuber	Cass			8/22/2007	Dip Net/Seine	111	6.0	46.87089	-94.51611
11035500	Ox Yoke	Cass			8/20/2008	Dip Net	187	14.5	46.86930	-94.46350
11036700	Lind	Cass			8/22/2007	Dip Net/Seine	377	10.0	46.82185	-94.47685
11040000	Jack	Cass	21		8/18/2008	Dip Net	142	20.0	47.06220	-94.44670
11041200	**Birch**	Cass			8/20/2008	Dip Net/Seine	1284	7.7	46.93846	-94.54518
11041500	Pike Bay	Cass			8/19/2008	Dip Net	4760	15.1	47.35404	-94.57073
18039800	Roy*	Crow Wing	1		8/21/2007	Dip Net	241	17.0	46.50490	-94.32830
18039900	Nisswa*	Crow Wing	2		8/21/2007	Dip Net	207	13.0	46.51940	-94.29790
18041600	Lizzie	Crow Wing			8/22/2007	Dip Net/Seine	370	4.5	46.80258	-94.32470
27011800	Fish	Hennepin			5/30/2007	Dip Net/Seine	233	2.7	45.09178	-93.46333
27013300	Minnetonka	Hennepin			5/5/06	Dip Net/Seine	14101	8.2	44.90972	-93.64446
27013700	**Christmas**	Hennepin	19		5/16/2006	Dip Net/Seine	267	20.0	44.89699	-93.54333
27017901	**North Little Long**	Hennepin	15		5/29/2007	Dip Net	65	15.0	44.94960	-93.70820
62005400	McCarron	Ramsey			7/20/2007	Dip Net/Seine	68	8.4	44.99819	-93.11306
71009600	Thompson*	Sherburne	10	2	9/20/2007 6/23/2008	Dip Net/Seine	95	8.0	45.35770	-93.77760
71015900	Long	Sherburne			6/23/2008	Dip Net/Seine	174	6.0	45.46829	-94.07443
73030700	Sieben	Stearns			9/20/2007	Dip Net/Seine			45.55706	-94.49105
73000100	Dallas	Stearns			9/20/2007	Dip Net/Seine	20	5.5	45.40722	-94.09038
73000400	Long*	Stearns	25		8/8/2007	Dip Net	49	10.5	45.39550	-94.10320
73000600	Crooked*	Stearns	7		8/8/2007	Dip Net	65	10.5	45.39030	-94.11150
73003700	**Pearl**	Stearns			6/24/2008	Dip Net/Seine	733	3.7	45.39900	-94.30635
73005500	**Grand**	Stearns	15		6/23/2008 7/23/2008	Dip Net/Seine	665	4.0	45.43730	-94.33720
73006400	**Kraemer**	Stearns			8/30/2007	Dip Net/Seine	192	5.0	45.55083	-94.36527
73007000	Watab	Stearns			9/19/2007	Dip Net/Seine	88	11.6	45.59913	-94.29323
73009600	Schuman*	Stearns	33	1	7/31/2007	Dip Net	N/A	12.0	45.57090	-94.45550
73009700	Kreighle*	Stearns	41	5	7/31/2007 8/31/2007	Dip Net/Seine	126	20.0	45.57890	-94.47890

DOW#	Lake	County	Least Darter	Pugnose Shiner	Date	Sampling Gear	Acres	Water Clarity (feet)	Latitude	Longitude
73009800	Pitts	Stearns			9/19/2007	Dip Net/Seine	93	2.7	45.56650	-94.50013
73010000	Kalla	Stearns			9/20/2007	Dip Net/Seine	103	5.4	45.56618	-94.47796
73010100	Schmid*	Stearns	26	3	9/19/2007	Dip Net/Seine	34	10.4	45.56550	-94.45240
73010200	Big Watab	Stearns	2		8/7/2007	Dip Net/Seine	227	10.0	45.55160	-94.45020
73010400	Island	Stearns			8/8/2007	Dip Net/Seine	120	13.0	45.55443	-94.39901
73010600	Big Fish*	Stearns	5	4	8/7/2007	Dip Net/Seine	558	12.0	45.51820	-94.46280
73010700	Long*	Stearns	10		9/21/2007	Dip Net/Seine	163	7.0	45.52480	-94.47740
73011700	Big Spunk	Stearns	15	10	7/31/2007 8/31/2007	Dip Net/Seine	440	10.0	45.59330	-94.47130
73012200	Ochotto*	Stearns	13		7/31/2007	Dip Net	40	14.4	45.62040	-94.44820
73012300	**Lower Spunk***	Stearns	1	16	7/31/2007 8/30/2007	Dip Net/Seine	280	7.5	45.61780	-94.45940
73012500	Achman	Stearns			8/8/2007	Dip Net/Seine	47	12.0	45.60428	-94.40299
73012800	**Middle Spunk***	Stearns	38	1	7/31/2007 8/30/2007	Dip Net/Seine	236	10.0	45.60680	-94.46520
73012900	Minnie	Stearns			8/31/2007	Dip Net		6-12	45.59981	-94.45630
73017200	Clear	Stearns			8/7/2007	Dip Net/Seine	121	8.5	45.52900	-94.53472
73030100	unnamed	Stearns			9/21/2007	Dip Net		6-12	45.61764	-94.47535
82015900	**Forest***	Washington	7		5/30/2007	Dip Net/Seine	2251	6.3	45.27390	-92.94610
86001100	Charlotte	Wright			7/24/2008	Dip Net/Seine	235	16.0	45.15071	-93.74732
86006600	Birch*	Wright	20		7/24/2008	Dip Net/Seine	76	7.7	45.29520	-93.88300
86013400	Maple*	Wright	2	4	7/10/2008	Seine	777	8.8	45.22656	-93.98005
86014600	Ida*	Wright	4		7/10/2008	Dip Net/Seine	231	15.0	45.30370	-93.90440
86022700	**Cedar**	Wright			7/10/2008	Dip Net/Seine	783	5.0	45.26929	-94.06463
86023300	Sugar*	Wright	17	4	7/10/2008	Dip Net/Seine	1020	9.8	45.31780	-94.03780
86023400	Bass	Wright			7/23/2008	Dip Net	218	13.7	45.32202	-94.10217
86023800	Nixon*	Wright	13	8	7/31/2008	Dip Net/Seine	56	9.0	45.35730	-94.05650
86025100	Pleasant	Wright			7/10/2008	Dip Net/Seine	571	5.5	45.27491	-94.12468
86027100	Moose*	Wright	10	7	7/24/2008 7/31/2008	Dip Net/Seine	88	15.5	45.22560	-94.23580

Occurrences, water quality and habitat: Lakes in the Avon Hills area of Stearns County had the greatest frequency of occurrences at 13% followed by Cass (8%) and Wright (6%) counties. Typical characters of these lakes were crystal clear water transparencies that promoted robust growth of submergent vegetation. Minimally developed shorelines or lots concentrated in clusters leaving expansive and uninterrupted vegetation zones. In contrast, lakes ringed with development, even with good to excellent transparencies, cannot support either species if vegetation is eliminated or reduced to small isolated patches. Least darter and pugnose shiners were generally restricted to lakes with water transparencies greater than six feet. However, occurrences less than that depth include: Minnewashta (4.3), Little Boy (5.0), Wabedo (5.3) and Grand (4.0). Secchi disk readings were obtained from DNR Section of Fisheries data and not recorded at the time these surveys were conducted. However, during this study, only Little Boy appeared to have too low a transparency to support either species. Both species are also rarely found in dark, tea stained lakes and streams usually associated with peat bogs.

Vegetation association: Aquatic plant occurrence and relative abundance data from the IBI surveys recorded 32 species (ranked as common or abundant) associated with the three targeted species (Table 4). The least darter was associated with 25 plant species, pugnose shiner (20) and longear sunfish (6). Muskgrass had the greatest frequency of occurrence for all species: least darter - 60.8% (14 of 23 stations), pugnose shiner - 71.4% (15 of 21 stations) and longear sunfish - 100% (4 stations). The second most frequently occurring species with the least darter were slender naiad and bladderwort (17.4%), pugnose shiner were yellow pond-lily (33.3%) and cattail (28.6%) and longear sunfish were slender naiad and American eelgrass (50.0%).

Table 4. Aquatic vegetation species associates ranked abundant or common at targeted fish species IBI stations.

Common Name	Species Name	Least Darter 23 stations	Pugnose shiner 21 stations	Longear Sunfish 4 stations
Watershield	Brasenia schreberi		1	
Lake-bank Sedge	Carex lacustris		1	
Coon's Tail	Ceratophyllum demersum	2		
Muskgrass	Chara sp.	14	15	4
Threeway Sedge	Dulichium arundinaceum	1		
Spikerush	Eleocharis sp.		1	
Canadian waterweed	Elodea canadensis		2	
Horsetail	Equisetum sp.		2	
Lesser Duckweed	Lemna minor	1		
Star Duckweed	Lemna trisulca	1		
Eurasian Watermilfoil	Myriophyllum spicatum	2		
Slender Niaid	Najas flexilis	4	1	2
Niaid	Najas sp.	2		
Yellow Pond-lily	Nuphar variegata	3	7	
American Water-lily	Nymphaea odorata	3	5	
Curly Pondweed	Potamogeton crispus	1	1	
Grassy Pondweed	Potamogeton gramineus	2	2	1
Illinois Pondweed	Potamogeton illinoensis	1		
Floating Pondweed	Potamogeton natans	1	1	
Sago Pondweed	Stuckenia pectinata	3	2	
Flatstem Pondweed	Potamogeton zosteriformis	1	1	
Cursed Crowfeet	Ranunculus sceleratus		1	
Grassleaf Arrowhead	Sagittaria graminea	1		
Hardstem Bulrush	Scirpus acutus	2	5	
Bulrush	Scirpus validus	2	1	
Bulrush	Scripus sp.	1		
Common Water-flaxseed	Spirodela polyrhiza	1		
Cattail	Typha sp.	2	6	1
Bladderwort	Utricularia sp.	4	2	
American Eelgrass	Vallisneria americana	2		2
Wild Rice	Zizania palustris (aquatica)	2		1
Grassleaf Mud-plantain	Zosterella dubia		1	

Revised range maps: New occurrences found during these surveys have been used to update the distributional data on the three species (Appendices 1-3). The least darter and pugnose shiner share a similar distribution pattern in Minnesota. They are most widespread in the Upper Mississippi drainage in north central Minnesota. There are also clusters in the upper Otter Tail River (Red River of the North drainage) and upper Pomme de Terre River (Minnesota River drainage). Both species are extremely rare in the Lake Superior and Lower Mississippi River drainages. Extant populations of longear sunfish are restricted to the northern third of the state and extremely spotty in distribution. However, fish surveys scheduled for the Boundary Waters Canoe Area Wilderness in 2009 and 2010 are anticipated to reveal new occurrences.

Conclusions and Recommendations

This study helped augment earlier Minnesota County Biological Surveys within these counties , but lacked a fish sampling component. These results are encouraging, but surveys were generally restricted to lakes with public accesses or connecting lakes via navigable streams. The three targeted species must occur in scores of other lakes that will probably never be surveyed. Instead of attempting to physically survey every one, future funding should be invested in a water GAP analysis to identify lakes that likely have habitats and water quality suitable for the species. Monitoring should begin on extant lake populations where there are impacts in the watershed causing a decline of water transparency or growth and coverage of muskgrass beds. When the water quality does improve in lakes where pugnose shiners historically occurred (Table 1), reintroductions should be considered. Currently, there are 5 lakes in the table that have transparencies greater than 6 feet and Christmas, Forest and Harriet had vegetation surveys done during this study that should indicate their suitability for future reintroductions. Additional research needs include Minnesota life histories for the pugnose shiner and longear sunfish and a genetic analysis of the least darter and pugnose shiner from all the drainages they occur in the state. Finally, the status of Special Concern appears appropriate for the least darter. The longear sunfish should be temporarily elevated to Special Concern until additional distributional data is compiled to determine a final status for the species. However, the pugnose shiner may warrant Threatened status due to the species typically low abundance at extant localities and history of extirpations.

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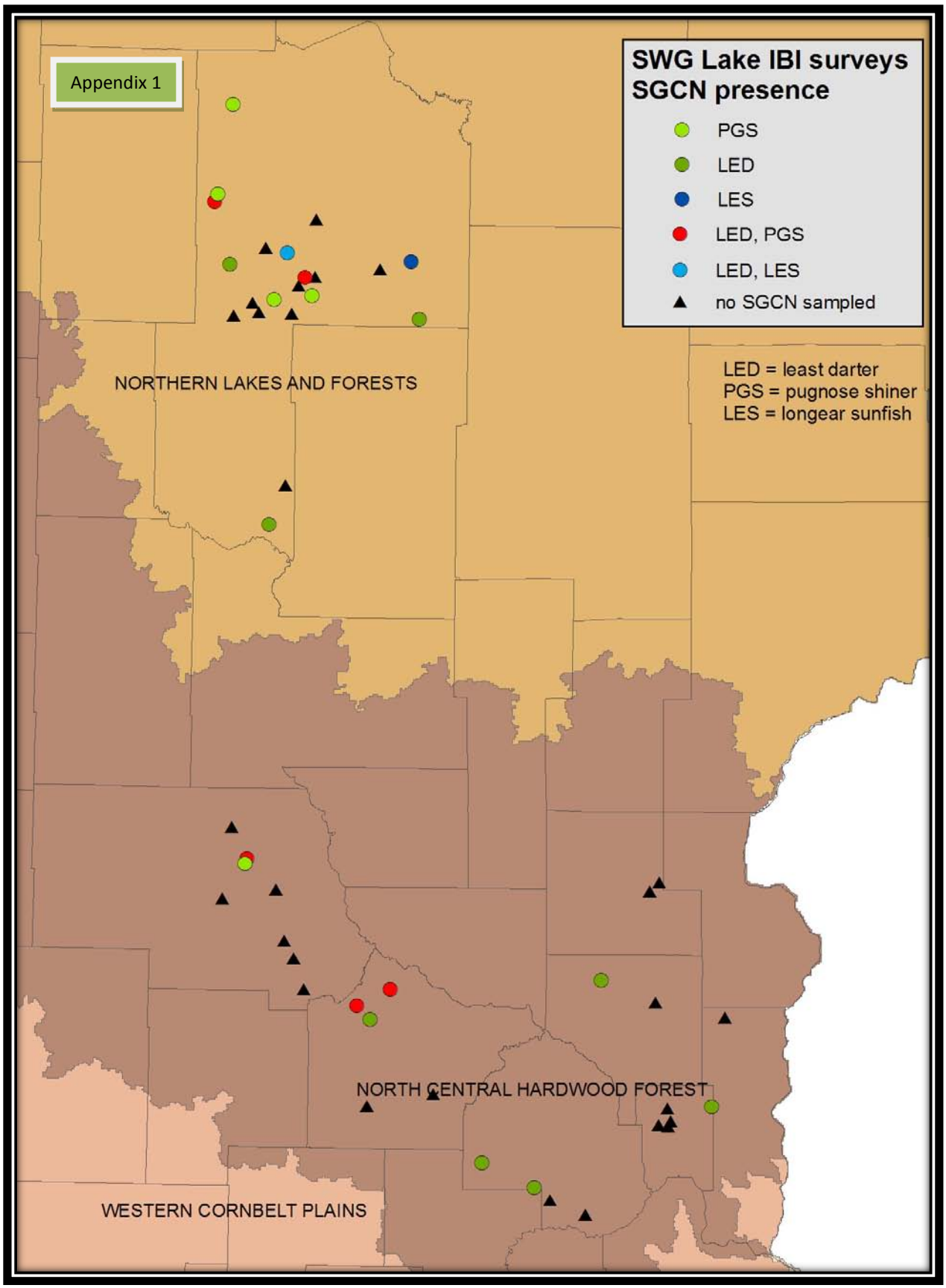
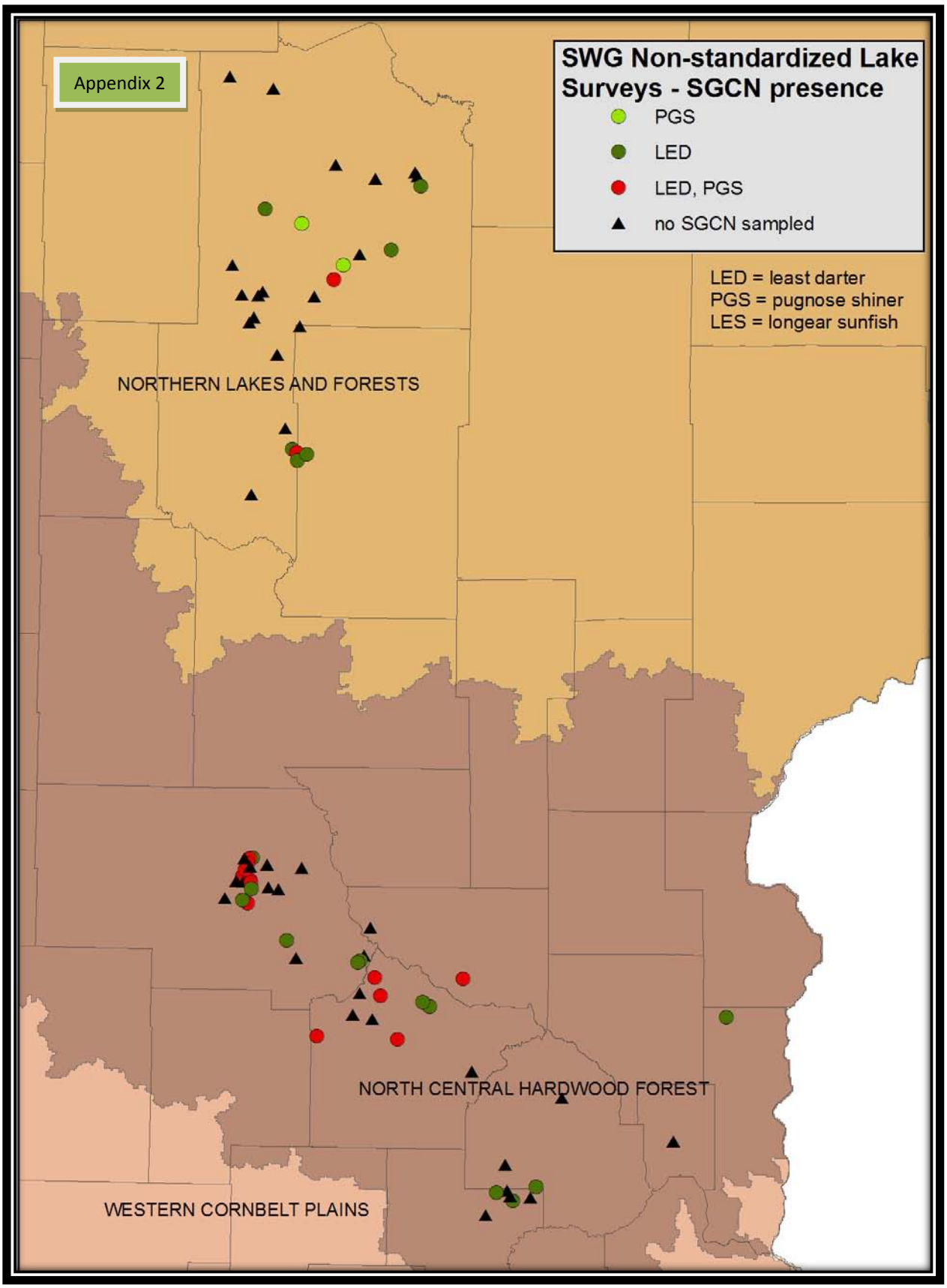
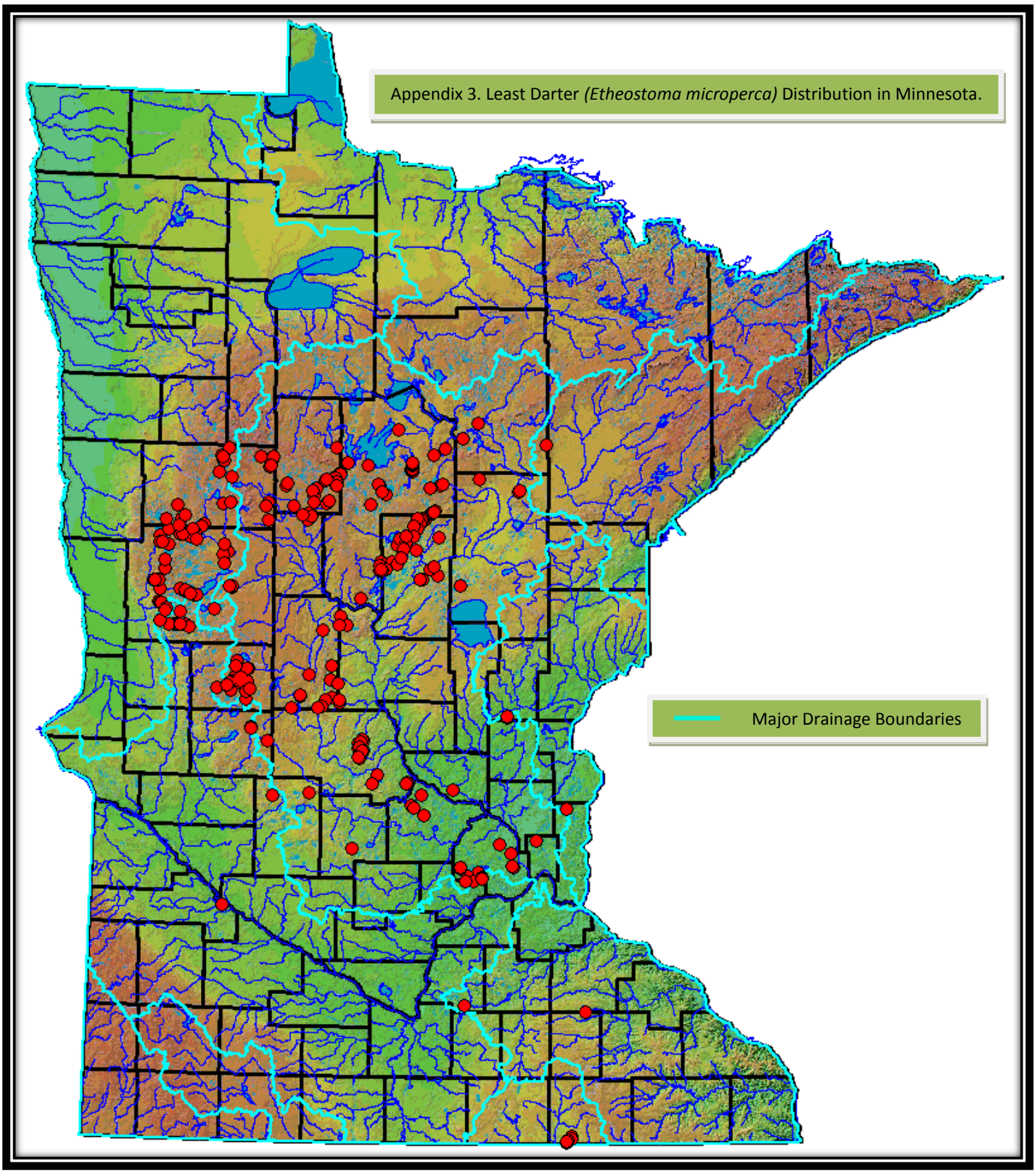
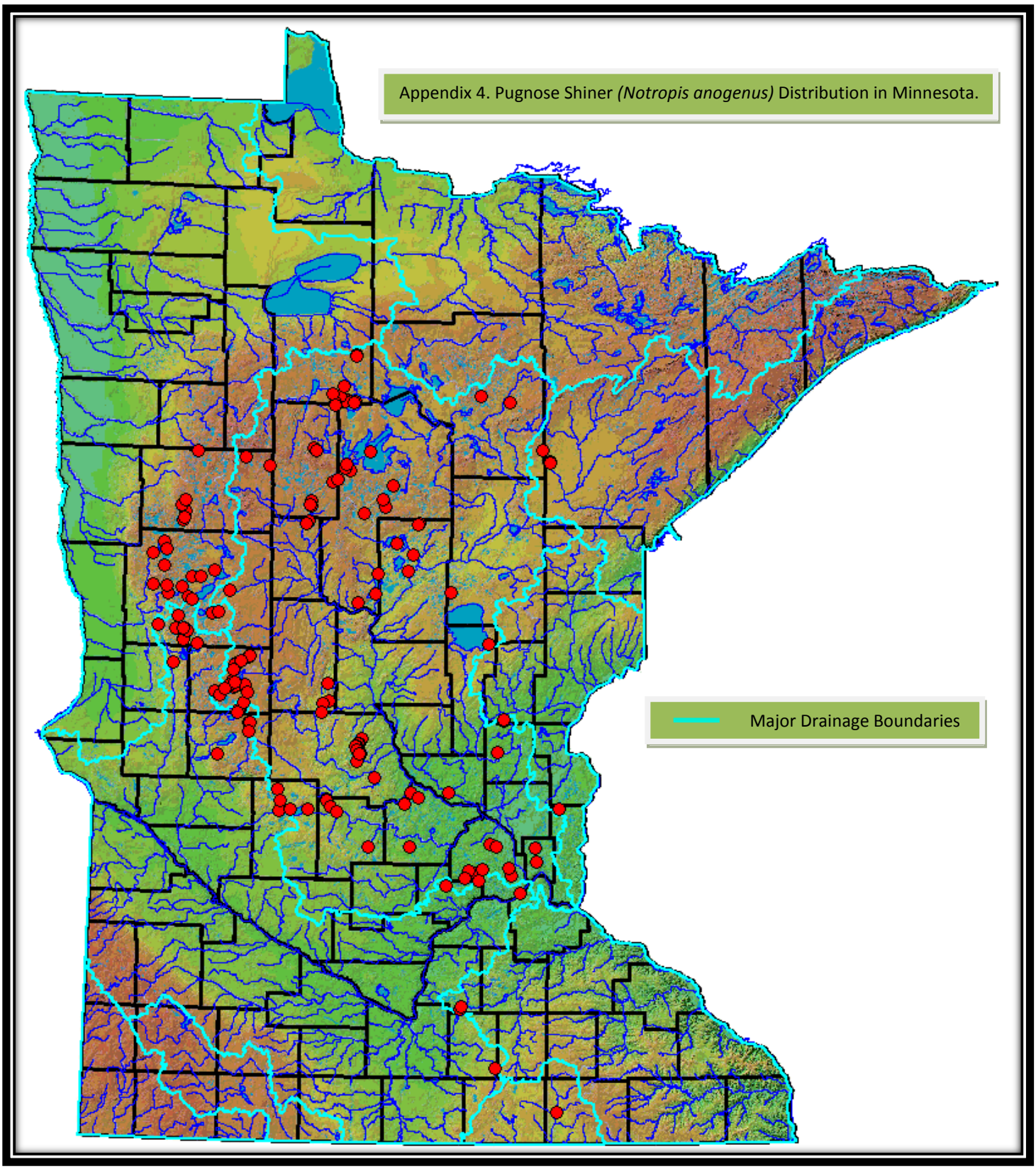
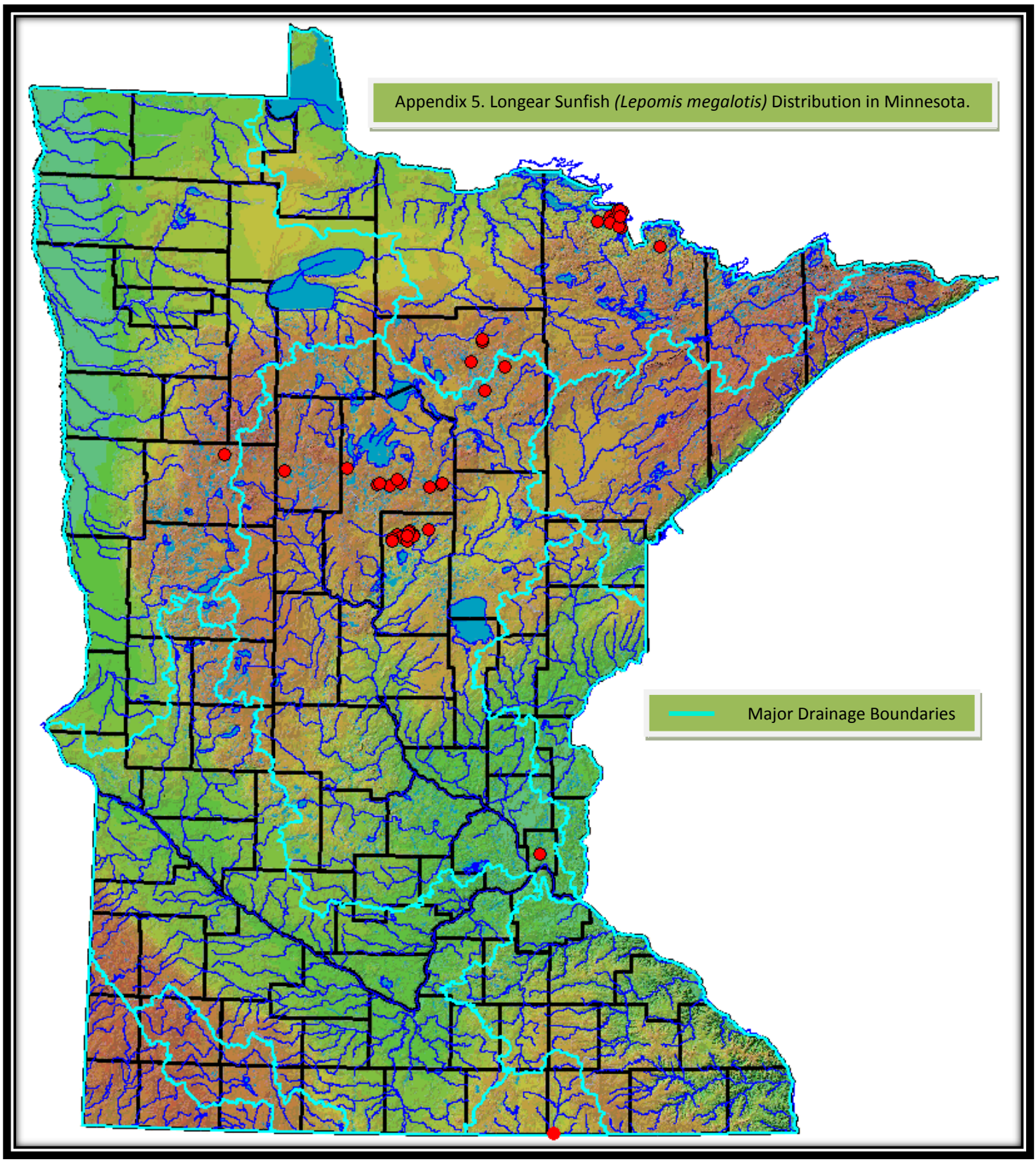

Appendix 1
SWG Lake IBI surveys
SGCN presence
PGS
LED
LES
LED, PGS
LED, LES
no SGCN sampled
LED = least darter
PGS = pugnose shiner
LES = longear sunfish
NORTHERN LAKES AND FORESTS
NORTH CENTRAL HARDWOOD FOREST
WESTERN CORNBELT PLAINS


Appendix 2
SWG Non-standardized Lake Surveys - SGCN presence
PGS
LED
LED, PGS
no SGCN sampled
LED = least darter
PGS = pugnose shiner
LES = longear sunfish
NORTHERN LAKES AND FORESTS
NORTH CENTRAL HARDWOOD FOREST
WESTERN CORNBELT PLAINS


Appendix 3. Least Darter (Etheostoma microperca) Distribution in Minnesota.
Major Drainage Boundaries


Appendix 4. Pugnose Shiner *(Notropis anogenus)* Distribution in Minnesota.
Major Drainage Boundaries


Appendix 5. Longear Sunfish (Lepomis megalotis) Distribution in Minnesota.
Major Drainage Boundaries