

Experimental/Special Regulation Proposal Form

Lake Name: DOW# Big Sandy Lake (01-0062); Aitkin Lake (01-0040); Sandy River Lake (01-0060); Flowage Lake (01-0061); Sandy River (M-120) from confluence of Mississippi River to Aitkin County Road 62; Prairie River (M-120-5) below the confluence with the Tamarack River (M-120-5-2); and the West Savanna River (M-120-5-1) below Aitkin County Road 14.

County: Aitkin

Region/Area: II / Aitkin F211

a) Proposed Regulation: Harvest slot limit for walleye (14-18 inches, with one allowed over 26 inches). This regulation would then potentially change to one that allows more harvest of mature male walleye once objectives are met for increasing female spawning stock. We propose to implement regulation in 2011, with first review for changing in 2018 and final review by 2023.

b) Documented Problem or Need: Big Sandy Lake is a large reservoir system, which previously had good natural reproduction of walleye from both in-lake and tributary spawning areas, but which has an apparent lack of larger fish in the population. In 142 standard assessment gill nets that have been set between 1975 and 2009, only 8 walleye have been sampled that were 20 inches or larger (or 0.06 20-inch and larger fish per net); whereas, the catch rate of 20-inch and larger walleye in 18 nets set in 1956 was over 0.25 fish per net. It has been suggested that the poor size distribution was due to the poor growth rates for walleye (Figure 1); however, size distribution in another lake with a similar slow growth rate suggests that Big Sandy could produce larger fish (Figure 2). In addition, it was suggested that larger fish from Big Sandy stay in up-river waters past the date of the Big Sandy assessments in July; however, the faster growth rates (Figure 1) of fish captured in those waters suggest they are not from Big Sandy.

Prior to 1995, Big Sandy had a long history of walleye stocking. Subsequent evaluations indicated that year classes stocked and not stocked ranked equally well suggesting stocking had little or no effect (Figure 3), therefore fry stocking was discontinued in 1996. Fitting a Ricker stock-recruitment curve to Big Sandy data indicated spawner biomass was the only variable that was tested that significantly ($p < 0.001$) explained recruitment variation (Figure 4). Fry stocking, water levels, and changes in water level were not significant components of recruitment ($p = 0.25_{\text{fry}}, 0.14_{\text{water level}}, 0.44_{\text{change in water level}}$). Subsequent surveys indicated that natural reproduction was exceptionally good in each year from 1994 thru 1998 (this includes the one fry stocked year of 1995). This resulted in an excellent gill net catch rate in 1999 (9.4/net). However, by 2001 there were relatively few fish from these year classes remaining in the fishery and gill net CUE dropped to 3.3 per net, and then to 2.3 per net by 2009. The low catches in recent years is primarily due to angling harvest and poor recruitment from 1999-2001 and 2004. Catch curve analyses suggest extremely high mortality for walleye between ages 4 and 6 ($A \sim 70\%$ annually; Figures 5 and 6). Assuming an average natural mortality rate of $M = 0.24$, and the total mortality rate of $Z = 0.69$ (Figure 5 ages 4-9), then the rate of exploitation is $u = 33\%$ for these ages. Exploitation between ages 4 and 6 appears even higher (over 50%). These

rates are considerably higher than what has been considered safe for harvesting walleye, and suggest that high angler harvest may be the reason for the poor size structure and lack of larger fish. Angler harvest at Big Sandy averaged about 2 pounds/acre (1988 and 2001 creel surveys), which is not excessive for the lake type; however, most of the harvest is made up of fish less than 14 inches long (Figure 7). This high acceptance of small walleye in the anglers' creel and the extremely high exploitation rate for younger fish suggest the lower abundance and poor size structure is due to over-exploitation.

In addition to a loss of fishing quality, the lack of mature female walleye in the population may also be limiting or increasing the variability in recruitment. Since the 1990s, only the 2002, 2003 and 2005 year classes appeared to be reasonably strong (near average). Very few fish from the very strong 1994-1998 year classes were observed in the spring 2009 trap net and electrofishing assessments, suggesting that mortality is high enough to severely deplete year classes well before senescence. This results in a spawning stock that is comprised primarily of young individuals. Over eighty percent of the female spawning stock, comprising more than fifty percent of the female spawning stock biomass, was age 7 or less, which is a considerably higher proportion of young females than in other waters (Figure 8). This results in sporadic and abrupt changes in spawning stock as strong year classes recruit, and then disappear as they are harvested. Using methods of Gangl and Pereira (2003) to evaluate spawner age diversity using gill net data, it is apparent that spawner age diversity has been declining in the last several gill net assessments (Figure 9) and is below the threshold that may indicate over-exploitation. The other BPIs were evaluated (Table 1), and many also suggested over-fishing; however, due to the uniquely slow growth rates at Big Sandy the thresholds for evaluation of the parameters that are affected by growth may not be adequate.

Figure 10 graphically illustrates the sizes of fish afforded protection by the proposed regulation. By protecting young fish there should be better survival of age 4 fish, which should maximize growth potential of these juveniles. By also protecting larger spawning females, spawning stock biomass would stabilize and would be able to maintain spawning potential (recruitment) past years of poor abiotic conditions.

c) Specific Objective: The objectives are: 1) to reduce total mortality of age 4 and 6 walleye to less than 60% 2) to increase female spawning stock biomass to greater than 2 lbs/acre as measured by q_{abg} ; 3) to improve female spawner age diversity to above $H=0.575$; and 4) to improve the angler catch rates of walleye between 14 and 18 inches by at least 150%.

d) Justification:

- a. Biological: Low female spawning stock, overfishing appears likely, population should be sustainable with natural reproduction as long as spawning stock is not depleted and angler harvest is at a more manageable level.

- b. Social: Will result in improved quality of angling. There appears to be much local support for “doing something”.
- c. Political: Big Sandy Lake Association has been supportive of improving fishery and is supportive of special regulations.
- e) Management Activities: Periodic test netting, work with lake association to identify spawning areas, work with Corps of Engineers to minimize water level affects to recruitment. Aquatic Management Areas have been acquired to protect spawning and some nursery areas from development. Historical stocking activities have occurred.

Simulation Modeling: WAE Size structure model (Jacobson 2003) and a Ricker (1975) yield per recruit model (stratified by sex and adjusted for angling selectivity) were used to evaluate potential changes in walleye population due to changes in regulation. Differences in models were apparent (Table 2). The WAE size structure model incorporates a standard selectivity curve, which is considerably different than at Big Sandy (Figure 11). Conversely, the Ricker yield model is not suitable for evaluating bag limit changes. For most scenarios for which both models could evaluate, they gave similar results. Differences were apparent mainly at smaller sizes due to the unique angler selectivity at Big Sandy. Each of the “tool box” regulations, as well as several other regulations were modeled. The 17-26 inch toolbox regulation showed a marked improvement in spawning stock, with a moderate loss in yield to the angler, however the overfishing of the young fish was not addressed. The 17 inch minimum size regulation also showed a slight improvement to spawning stock, but with a major loss in yield and number harvested. The last toolbox regulation, the three fish bag limit, showed only a minor loss in yield, but with only a minor improvement in spawning stock (could only be modeled with WAE size structure model). Other regulations that were modeled were a variety of protected slot limits, minimum size limits, and some harvest slot limits. The 14 inch minimum size regulation showed nearly no change in yield, with only a moderate decrease in number of fish harvested (i.e. same pounds of slightly larger fish were harvested). This regulation, however, showed very minor changes to spawning stock. A 14-18 inch harvest slot showed great improvement to spawning stock with a moderate loss in yield and number caught. Results from this regulation scenario suggest a benefit from the protection of small fish (reduces overfishing) and protection of adults (improvement to spawning stock and catch rate of quality size fish). Although not directly modeled, it should be feasible to implement this regulation for a short period of time to build up spawning biomass (7-10 years), and then relax to somewhat more reasonable level that would make more use of older males, which do not attain lengths much greater than about 20 inches.

- f) Fish Community: Walleye, northern pike, yellow perch, tullibee, and white and shorthead redhorse suckers are the most common species captured in assessments (Table 2). While walleye have been relatively low in density compared to lake class averages, northern pike, yellow perch, and white suckers are near median levels, and tullibeas and shorthead redhorse are relatively abundant for this lake class. Shorthead redhorse have been increasing in recent years. In Big Sandy Lake, yellow perch are harvested at very low rates due to the occurrence of the parasitic yellow grub. Young of year yellow perch were, by far, the most common species sampled in shoreline

seining conducted in 1982 and 1990. Evaluation of the yellow perch/walleye relationship (VanEpps 1985) suggested that the reason for the poor early growth of walleye in Big Sandy Lake is the size differences between the two species as young of year. Much of the size distribution of young of year yellow perch were too large to be eaten by young of year walleye; therefore, the young of year are only preyed upon by walleye age 1 and older. In 2009, however, it appeared that YOY yellow perch were small enough to be used by YOY walleye, and it was reflected in the 5.0 inch mean length for YOY walleye (about 1 inch larger than average). Observations of the very few larger females indicate that these fish do have the ability to reach a larger size, but that their abundance is so reduced that few ever do. At a larger size these fish would have available relatively robust tullibee and yellow perch populations as forage.

- h) Public Acceptance/Response: The Big Sandy Lake Association has requested that we evaluate the Big Sandy fishery to determine if regulations could benefit the fishery. There has been a regular call to “increase the size of the fish” from the Big Sandy angling public. Depending upon whom you speak with, the desire for larger fish means to them either more 15-17 inch fish to keep, or more 20 inch and larger fish for catch and release fishing. I believe that the 14-18 inch harvest slot limit has the ability to accommodate both. However, this will mean a loss of the 11-13 inch fish in their harvest. This loss will be most notable in the first few years of the new regulation, since it will take a few years for these new surviving young fish to recruit into the harvestable range. Assuming a catch distribution similar to that of 2001, we should expect a 75% decrease in harvest by number and 65% decrease in yield for the first year. It will be important to monitor the fishery closely in the early stages to see that these young fish are indeed recruiting into the harvest at larger sizes. Regarding the upper protected slot range, the protection of spawners is a relatively popular activity and in this case appears to be warranted. In addition, planning to relax the regulation in the future once spawning stock is built up would make it even more appealing to the public. By relaxing the bottom end of the upper range of the slot limit, we would be able to make use of all age classes of male walleyes in the population, while still protecting female spawning stock.
- i) Effect on Other Divisions: The Enforcement Division would need to enforce the regulation, which is a departure from the statewide regulation; however, the local conservation officer has encouraged us to evaluate such rules. He has requested that this regulation also include the reach of Sandy River below the Libby Dam to the mouth of the Mississippi River. Although this would have no affect on the Big Sandy fishery, this would afford better enforcement abilities for the conservation officers.
- j) Alternatives: 1) Implement 17-26 inch tool box regulation, (slow improvement in SSB but does not reduce overfishing in the 4-6 year range); 2) Implement 17-26 inch tool box regulation and 3 fish tool box regulation (improves SSB and somewhat reduces overharvest of younger fish, although very few anglers harvest more than 3 walleye per day – about 15% of anglers that harvested fish in 2001); 4) Do nothing (likely need to resume stocking if spawning stock continues to decline).

k) Evaluation Plan:

Assessment work: Conduct a full survey in 2010 (as planned in current LMP) and population assessments every 3 years (including summer gill net and spring trap netting/electrofishing if feasible). Conduct annual fall electrofishing to index recruitment of juvenile walleye.

Creel Survey work: Collect annual May/June walleye length frequency distribution (LFD), working cooperatively with ECO invasives monitoring intern. Conduct more intensive quantitative/qualitative creel surveys in 2017 and 2020 (type of creel survey would depend upon available funding – if moneys are available for full creel survey then replicate 2001 survey, otherwise use Aitkin Office staff and Big Sandy Lake Association volunteers to collect angler CUE and fish LFD information only).

Benchmarks for success:

Female SSB doubles (as estimated from q_{abg} – current mean is about 1 lb/acre (Figure 12).

Diversity of mature females increases to above $H=0.575$ (Figure 9).

Total mortality of walleye ages 4 and 6 decreases to less than 60% as measured by gill net catch curves.

Angler catch rate for walleye 14-18 inches increases by at least 150%.

Other indicators of success are: Angler catch rate (no. caught/hour) of walleye over 18 inches doubles; yield rate (lbs harvested/hour) decreases by less than 30%; the abundance of old fish (age 10+) increases in gill net and spring trap net samples.

References.

Gangl, R. S. and D.L. Pereira. 2003. Biological performance indicators for evaluating exploitation in Minnesota's large-lake walleye fisheries. *North American Journal of Fisheries Management*. 23:1303-1311.

Jacobson, P. 2003. Walleye size structure model documentation. MN DNR unpublished.

Ricker, W.E.1975. Computations and interpretation of biological statistics of fish populations. *Journal of fisheries Research Board of Canada*, bulletin 191.

Van Epps, S. 1985. Lake survey sampling report for Big Sandy Lake, 1985. MN DNR federal aid completion report. F-29-R(P)-5, Study 2 Job 1.

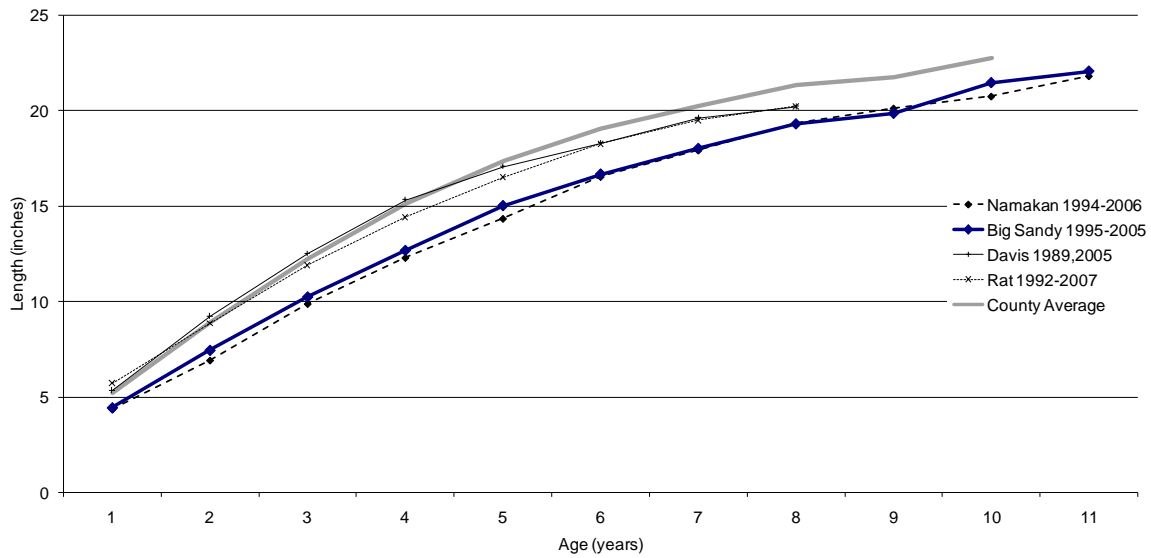


Figure 1. Comparison of back-calculated lengths at age for walleye at Big Sandy, with fish from Namakan, Davis, and Rat Lakes. Note that Davis and Rat are upstream from Big Sandy in the Sandy River sub-watershed.

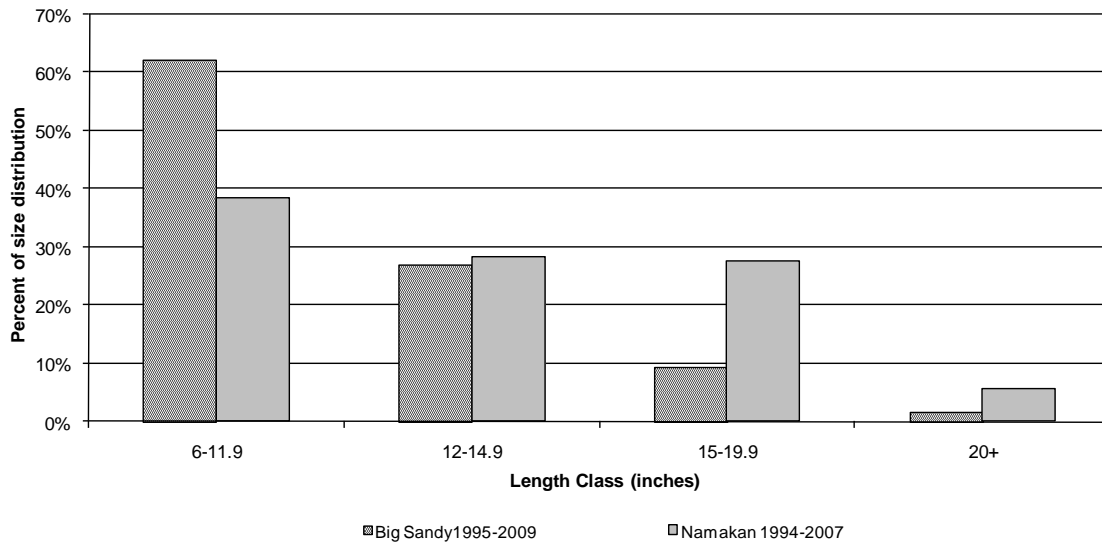


Figure 2. Historical length-frequency distribution of walleye captured in assessment gill nets at Big Sandy and Namakan Lakes.

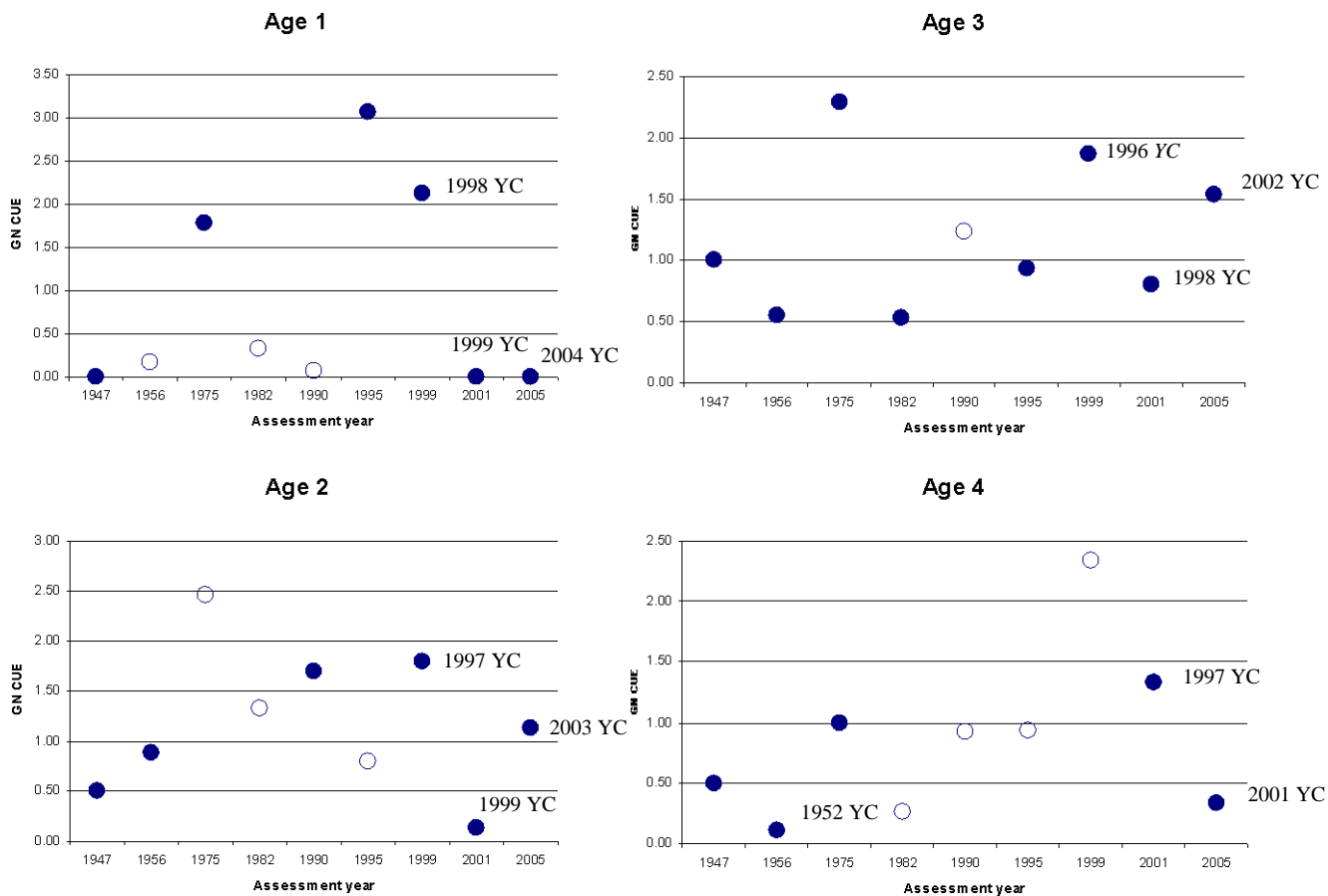


Figure 3. Gill net catch rates for walleye ages 1 through 4 at Big Sandy Lake, 1947-2005. Open circles denote years that were stocked. Note that the 1955 year class (age 1 in 1956) was stocked as fingerlings, whereas other years were stocked as fry. Another year class to note is the 1952 year class (age 4 in 1956), for which there were 5,680 fingerlings that were stocked; however, this year class was considered not stocked for purposes of this review due to such a low stocking rate (about 0.02 lbs per littoral acre).

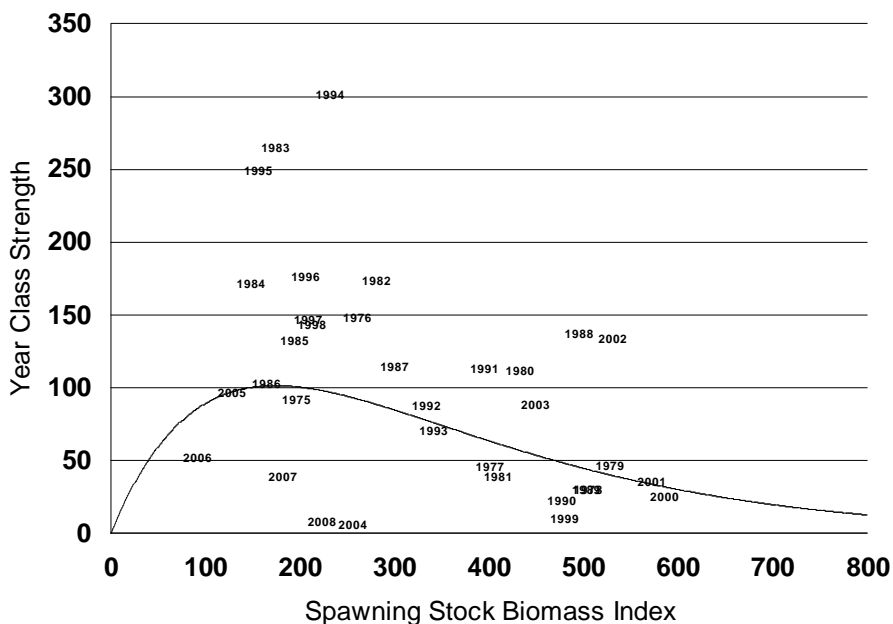


Figure 4. Ricker spawner:recruit function for Big Sandy walleye. Spawning stock index is a function of age 5-8 walleyes in the population and year class strength is Schupp's index based on GN CUE of age 1-8 walleye in the assessments. Data points are represented by the year class.

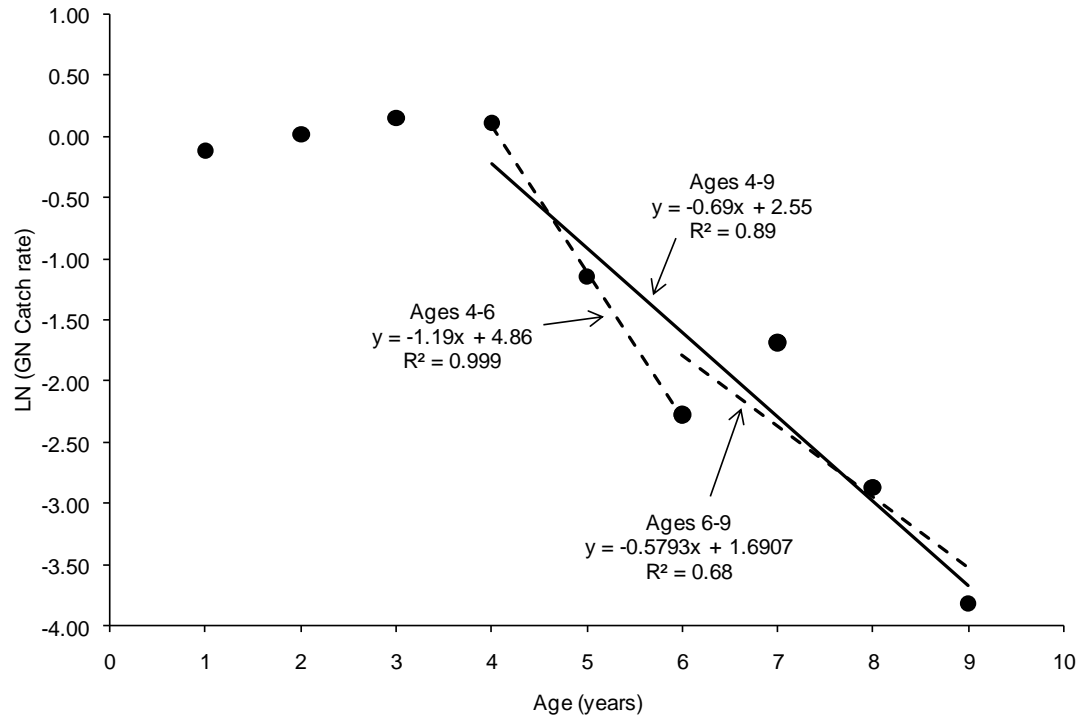


Figure 5. Catch curve of walleye from assessment gill nets, Big Sandy Lake 1990-2009 combined.

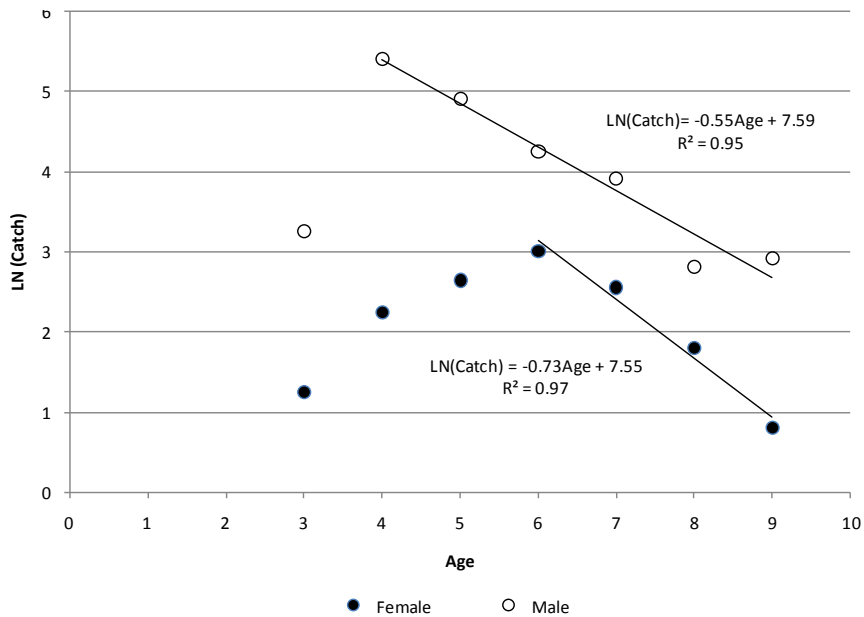


Figure 6. Catch curve of walleye from spring trap net and electrofishing assessments, by sex, Big Sandy Lake, 2000 and 2009 combined. Note that since these are spawning population samples, the catch curves likely underestimate total mortality (first age classes are likely not fully mature).

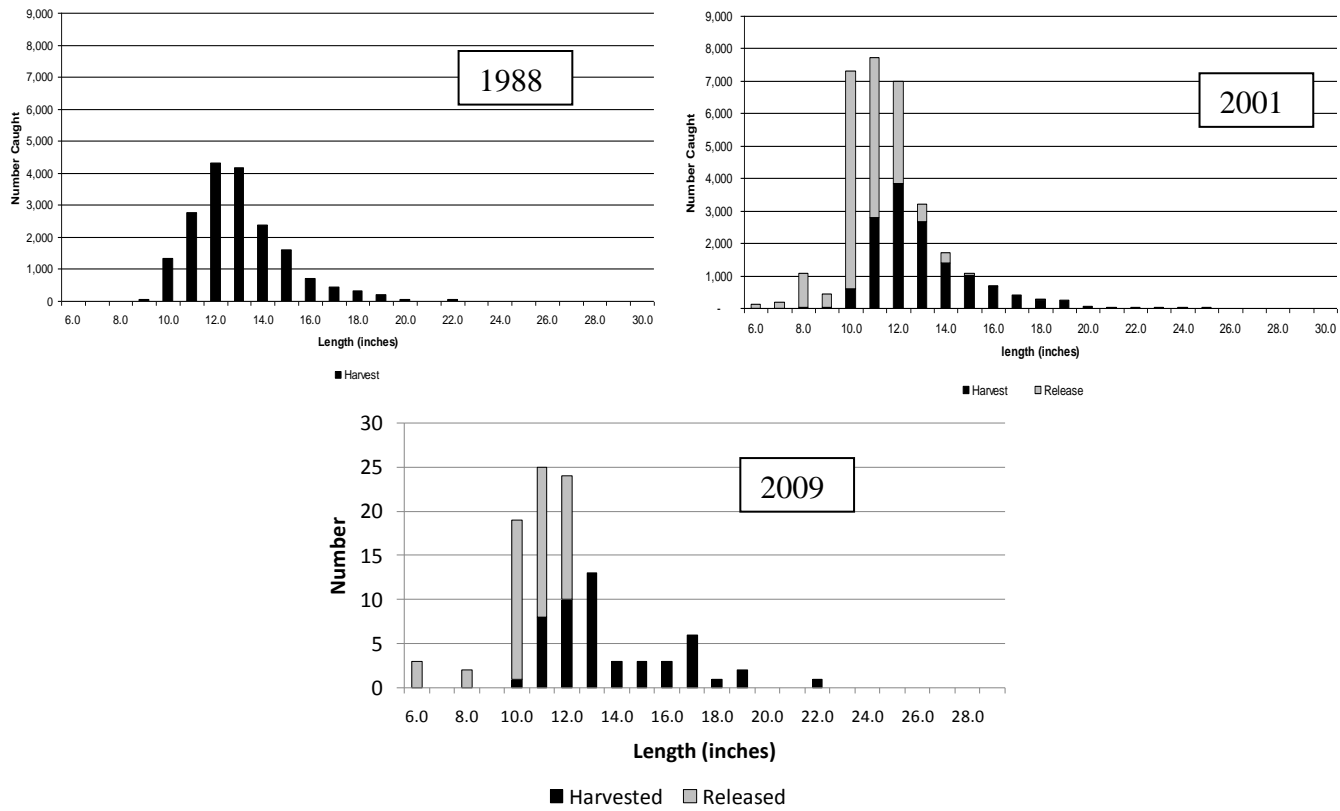


Figure 7. Length frequency distribution of the angler catch at Big Sandy Lake, 1988, 2001 and 2009. No release information was collected in 1988. Information from 2009 from ECO Resources Boat Inspector Intern who interviewed successful anglers only.

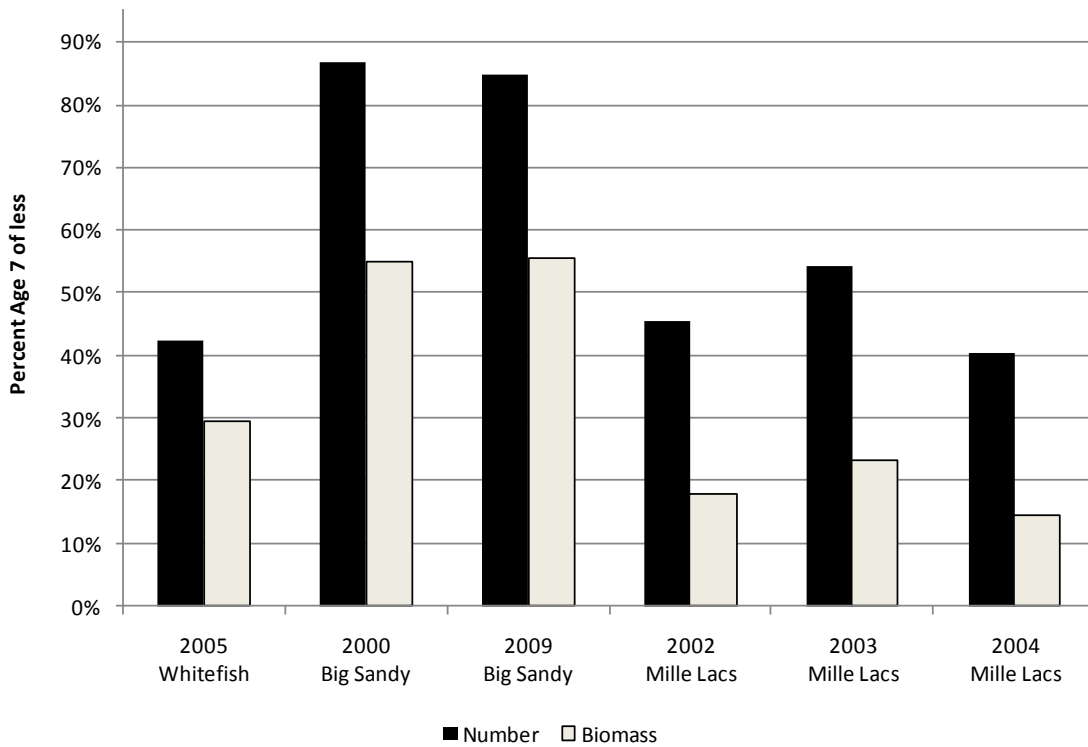


Figure 8. Percent of spawning stock age 7 or less observed in spawning run samples in 3 lakes with viable walleye spawning populations.

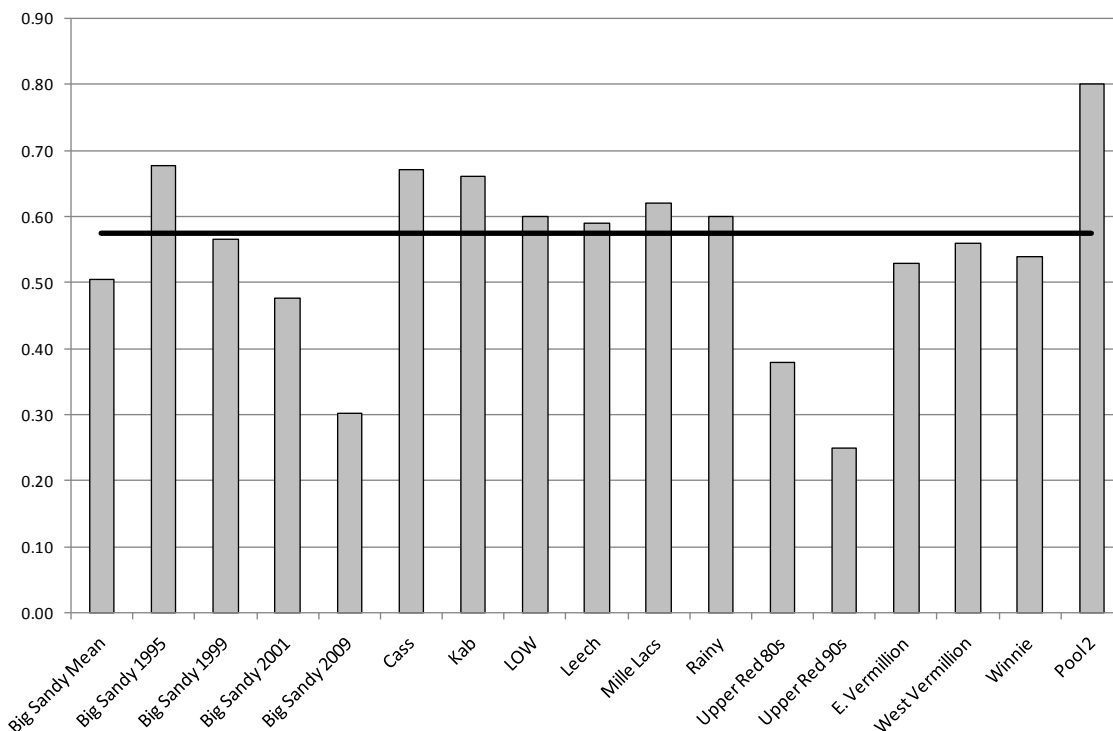


Figure 9. Mature female age diversity for Big Sandy and Minnesota's large walleye lakes. The horizontal line is the threshold used by Gangl and Pereira (2003) for interpreting condition of spawning stock. Values below threshold may indicate over-exploitation.

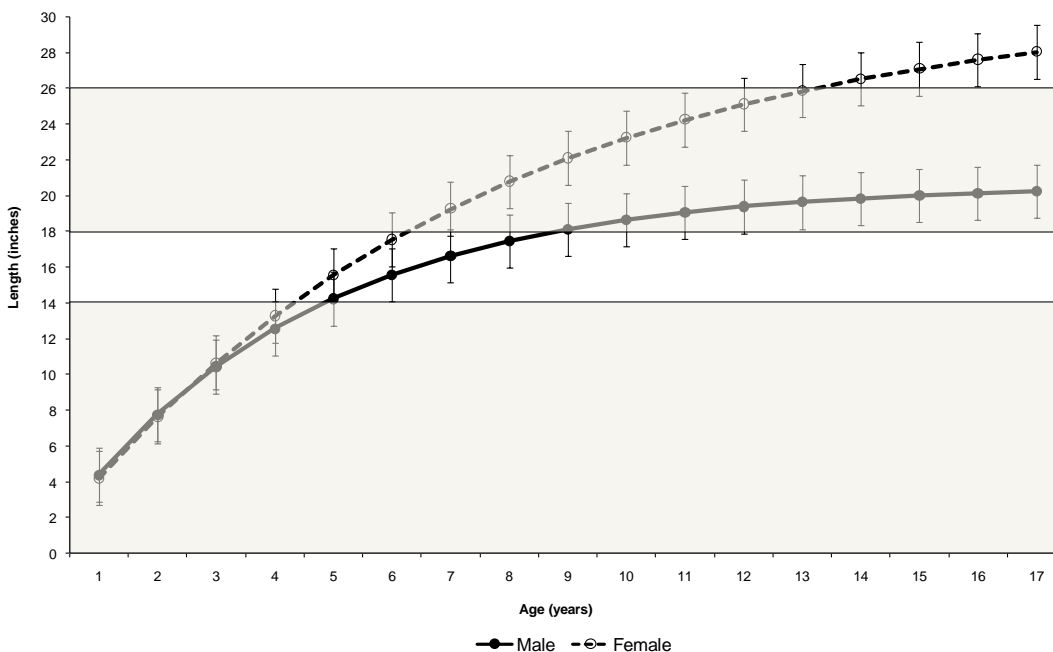


Figure 10. Growth of walleye at Big Sandy Lake. Von Bertalanffy functions were fit to the mean back-calculated lengths at age from the 1999, 2000, and 2001 assessments. Parameters were: females, $L_{\infty} = 31.0$, $K=0.13$, $t_0=-0.05729$; males $L_{\infty} = 20.6$, $K=0.2334$, $t_0=-0.02526$. Error bars mark three inch range for variation in each age class. Grey shaded area depicts sizes/ages protected by proposed regulation.

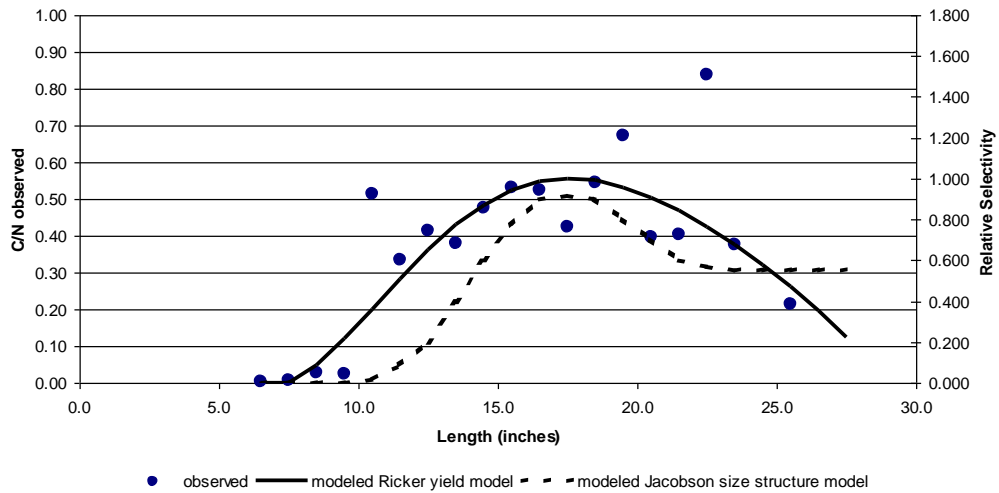


Figure 11. Relative angler selectivity used in models and observed Catch/Number in population (from qabg) of walleye at Big Sandy Lake.

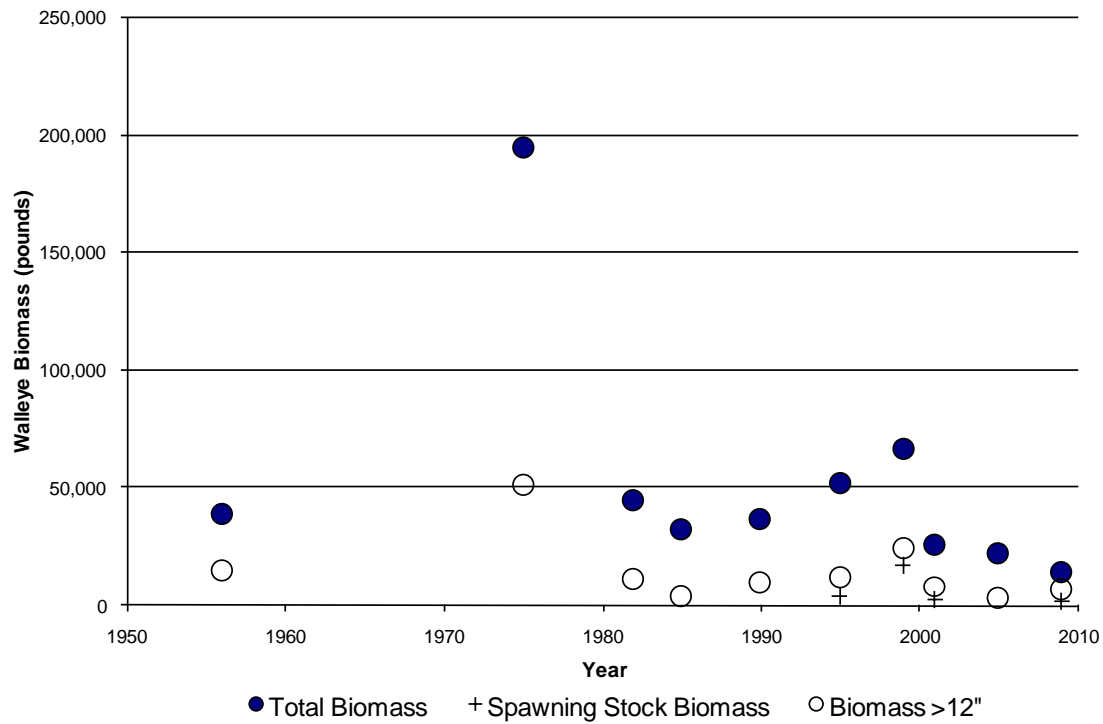


Figure 12. Walleye biomass in Big Sandy Lake, as estimated from gill net assessment catches and q_{abg} (Anderson 1998). Note that spawning stock biomass (mature female) was only estimable for 1995, 1999, 2001 and 2009.

Table 1. Biological performance indicators for Big Sandy Lake (Gangl and Periera, 2003).

Big Sandy Parameter	Observed	Predicted	Residual	Threshold	Suggests overfishing?
Omega (L_{∞}/K)	114	128	-14	4	No
Length at age 3	262	310	-48	5	No
Age at maturity	4.2	4.4	-0.2	-0.2	Yes (marginal)
Length at maturity	345	404	-59	-20	Yes
mean H (spawner diversity)	0.69			0.575	No
H ₂₀₀₉	0.3			0.575	Yes
CV of net CUE	0.38			0.36	Yes

Table 2. Results from simulation modeling of various regulation scenarios. Toolbox regulations are highlighted.

WALLEYE SIZE STRUCTURE MODEL (Jacobson 2003)

	17-26 PS	17 min	3 fish	14 min	16-20 PS	20-28 PS	14-17 PS	18-24 PS	18-26 PS	2 fish
Harvest lbs	-15%	-7%	-4%	0.8%	-12%	-2%	-6%	-6%	-7%	-9%
Harvest num	-9%	-35%	-14%	-5%	-13%	-1%	-18%	-3%	-4%	-24%
Harv rate	-8%	-30%	-8%	1%	-7%	6%	-13%	3%	3%	-19%
CUE >15"	29%	123%	49%	14%	58%	8%	78%	17%	18%	85%
CUE >20"	1000%	200%	300%	100%	500%	200%	200%	600%	600%	600%
Female SSB	218%	109%	79%	7%	145%	28%	72%	95%	116%	157%
u 3-9	-52%	-24%	-23%	-2%	-48%	-14%	-17%	-35%	-35%	-37%
Release mortality	97%	402%	157%	50%	154%	7%	218%	34%	38%	272%
Rel mort as percent of harv num	6%	21%	8%	4%	8%	3%	11%	4%	4%	13%

RICKER YIELD PER RECRUIT MODEL

	17-26 PS	17 min	14 min	16-20 PS	20-28 PS	14-17 PS	18-24 PS	18-26 PS	14-18 HS
Harvest lbs	-34%	-14%	-0.2%	-25%	-7%	-10%	-14%	-16%	-21%
Harvest num	-19%	-50%	-25%	-21%	-2%	-18%	-7%	-8%	-34%
Number>age 10=	646%	153%	40%	491%	125%	79%	285%	311%	394%
Females>age 10=	658%	110%	39%	120%	225%	49%	345%	393%	622%
SSB_Female	86%	74%	36%	32%	22%	26%	40%	45%	102%
u 4-6	-32%	-55%	-12%	-47%	0%	-41%	-9%	-9%	-21%
Release mortality	399%	456%	253%	320%	161%	242%	221%	240%	434%
Rel mort as percent of harv lbs	9%	8%	4%	7%	3%	4%	4%	4%	8%

Table 3. Assessment gill net catch history for Big Sandy Lake, 1947-2009.

Gill net	Year	1947	1956	1975	1982	1985	1990	1995	1999	2001	2005	2009
Number of nets		18	18	24	15	13	15	15	15	15	15	15
Suspended nets						3						
Yellow Perch		40.39	11.94	12.13	20.47	17.15	26.67	23.60	18.73	17.60	11.47	13.53
Yellow Bullhead			0.00	0.13	0.00	0.00	0.07	0.13	0.00	0.00	0.07	0.00
White Sucker	0.67	0.67	2.17	3.40	3.08	3.60	3.07	3.07	1.80	2.00	2.07	
silver redhorse		0.17	1.29	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
shorthead redhorse			0.00	0.00	0.00	0.46	0.80	0.47	2.80	1.07	1.93	1.67
Walleye	7.94	5.22	19.83	6.33	5.54	5.20	6.40	9.40	3.33	3.20	2.33	
Walleye <12			5.67	4.13	4.00	3.20	4.20	5.07	1.93	0.80	1.07	
Trout perch		0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Tullibee (Cisco)	5.56	2.17	2.92	3.60		0.13	8.33	3.93	15.00	9.87	3.20	
						31.3						
Rock Bass	0.44	0.06	0.46	0.07	0.46	0.80	0.13	0.60	0.27	1.33	0.67	
Pumpkinseed Sunfish		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Pike	16.28	0.89	4.13	4.00	5.46	3.13	5.80	5.60	5.07	4.67	2.80	
Northern Pike >24 inches			0.04	0.00	0.08	0.00	0.00	0.40	0.07	0.20	0.27	
Smallmouth Bass		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	
Burbot	0.39	0.06	0.00	0.07	0.15	0.20	0.33	0.07	0.00	0.00	0.07	
Brown Bullhead		0.00	0.38	0.67	0.15	2.13	0.33	0.07	0.40	0.13	0.00	
Bowfin (Dogfish)	0.11	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.07	
Bluegill		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black Crappie	0.17	0.22	0.67	0.53	0.38	0.60	0.00	1.93	0.07	0.13	0.13	
Black Crappie >10 inches		0.00	0.13	0.00	0.08	0.00	0.00	0.07	0.00	0.00	0.07	
Black Bullhead	0.00	0.06	2.00	0.00	0.08	12.33	0.07	5.53	0.33	0.00	0.00	

Table 4. Historical length distribution of walleye captured in standard assessment gill nets at Big Sandy Lake, 1947 - 2009.

Number of nets	18	18	24	15	13	15	15	15	15	15	15	Length Class (in)
Length Class (in)	1947	1956	1975	1982	1985	1990	1995	1999	2001	2005	2009	Length Class (in)
6		1					5					6
6.5			5	3	6		25	3				6.5
7		5	20	5	5		12	11		2	1	7
7.5			21	1	2		5	12	1	1		7.5
8		1	8	2	2	3		5		1	1	8
8.5			18	2	5	14	5	4	2	9	4	8.5
9		17	54	7	5	9	4	10	1	7		9
9.5			51	5	5	6	3	5	1	1		9.5
10		30	24	9	9	4	1	4	2	2	1	10
10.5			31	9	5	3		7	7	4	5	10.5
11		8	49	8	4	2	4	7	7	7	3	11
11.5			42	10	4	8	4	8	8	4	1	11.5
12		10	78	10	9	8	6	17	7	4	6	12
13		2	34	6	2	9	8	21	4	3	3	13
14		6	20	5		3	4	8	6		1	14
15		3	9	5		2	1	7			2	15
16		3	4		1	3	3	4	1			16
17		2	8	3	3	2	1	4	1			17
18		4	2	2		1	1	1	1	2	1	18
19		3	3				2	1				19
20		2		2			1	1				20
21		2										21
22								1				22
23		1								1		23
24												24
25												25
26									1			26
27							1					27
28												28
29												29
30												30
Total		100	481	94	69	78	96	141	50	48	29	
Over 20"		5	0	2	0	0	2	2	1	1	0	