Differences in Angler Catch and Exploitation of Walleye from Virginia Waters

Stephen J. Owens, *Virginia Department of Game and Inland Fisheries, 1320 Belman Road, Fredericksburg, VA 22401*

George Palmer, *Virginia Department of Game and Inland Fisheries, 1796 Highway Sixteen, Marion, VA 24354*

Thomas Hampton, *Virginia Department of Game and Inland Fisheries, 1796 Highway Sixteen, Marion, VA 24354*

Daniel Wilson, *Virginia Department of Game and Inland Fisheries, 1132 Thomas Jefferson Road, Forest, VA 24551*

Johnathan Harris, *Virginia Department of Game and Inland Fisheries, 4010 West Broad Street, Richmond, VA 23230*

Abstract: Walleye (*Sander vitreus*) were collected during late winter–early spring in 2008–2011 at seven sites across Virginia to evaluate angler catch and exploitation. A total of 3116 walleye were tagged with FD94 T-bar Floy tags at four small impoundments (<200 ha), two large impoundments (>200 ha), and the New River during the course of the study. Anglers were offered a US$20 reward for the return of each tag, and 530 tags (17%) were returned. Adjusted annual catch rates ranged from 15%–61%, with a mean of 29%. Annual exploitation ranged from 2%–29% with a mean of 12%. Mean total length (TL) of angler-caught walleye was largest in large impoundments (489 mm), next largest in the New River (465 mm), and smallest in small impoundments (418 mm; $P < 0.001$). Mean TL of walleye harvested from small impoundments (462 mm) were smaller than those harvested from large impoundments (508 mm) or rivers (507 mm) ($P < 0.001$).

Key words: Sander vitreus, harvest, southern populations, river, reservoir

Journal of the Southeastern Association of Fish and Wildlife Agencies 1:14–19

Populations of walleye (*Sander vitreus*) have long been regarded as an important component of sport fisheries in much of the northern United States and Canada, and have also been introduced into many southern U.S. waters to create additional fisheries (Kerr 2011). A key component of managing sport-fish populations and developing appropriate regulations is determining the amount of exploitation that can be sustained without substantially degrading the population. This is especially important for recreational walleye fisheries that are largely harvest-oriented and maintained through stocking. Angler effort and exploitation of walleye likely vary across geographic location, regulations, water body type, and fish densities, which makes prediction and management of exploitation difficult (Schmalz et al. 2011). Strategies around North America to manage walleye populations have come in the form of harvest regulations, stocking, and habitat protection or manipulation (Isermann and Parsons 2011). Unfortunately, exploitation rates are rarely documented for most walleye populations making it difficult to determine the need for harvest regulations (Schmalz et al. 2011). Tagging studies are commonly used to determine population impacts and angler exploitation of a variety of fisheries (Serns and Kempinger 1981, Larson et al. 1991, Muoneke 1994, Pegg et al. 1996), but few of these have been conducted on southern U.S. walleye fisheries.

Walleye fry and fingerlings have been stocked into numerous Virginia waters for 60 yr to provide new angling opportunities in the state. Historically, little emphasis was placed on establishing quality walleye populations in Virginia and, as a result, <2% of the state's anglers that fished in stocked walleye waters from 1978 to 1995 listed walleye as their preferred species due to low catch rates (Steinkoenig 1997). Subsequently, management goals and objectives were developed to establish high-quality walleye populations and increase angling interest, which resulted in improved populations and an increasing walleye angler constituency (Hampton 2000). In Virginia, all walleye populations but those in the New River are sustained by stocking at an annual rate generally between 20 and 40 fish ha^{-1} for impoundments and between 300 and 1,250 fish km^{-1} for lotic systems; therefore, specifically managing spawning-stock size to prevent population collapse is usually not important to maintain these fisheries. However, maintaining populations that can sustain increasing angler pressure while continuing to fulfill angler expectations is vital. Determining appropriate regulations to maintain their populations is further complicated by Virginia's diverse walleye waters (small impoundments, large impoundments, and rivers), each providing a potentially different management approach to maintain desired populations.

Thus, our objectives were to (1) estimate angler catch and exploitation, (2) evaluate whether exploitation was affecting the size structure, and (3) determine if angler use varied among water body types.

Methods

Walleye populations were monitored at seven sites across Virginia from 2008 to 2011. Walleye were collected by boat electrofishing during late winter and early spring and tagged with FD94 T-bar Floy tags. We attempted to tag 100 walleye each year at four small impoundments (<200 ha) and the New River, and 250 walleye at the large impoundments (>200 ha) (Table 1). Sequentially numbered Floy tags were printed with "Reward" and the address and phone number of the local Virginia Department of Game and Inland Fisheries (VDGIF) office. Each fish was measured (total length [TL]), weighed (g), sexed, and tagged near the posterior terminus of the spiny dorsal fin prior to release. Tagging was discontinued at Lake Whitehurst in 2010 due to loss of public access. Lake Orange was added as a replacement small impoundment because it offered both a good walleye fishery and good public access.

Multiple media outlets were used to notify anglers about the study; information about the survey was disseminated via press releases, newspaper articles, outdoor magazines, and the VDGIF website (MacRitchie and Armstrong 1984, Muoneke 1992). Also, posters explaining the tagging program were displayed at each waterbody to provide anglers with information on how to return tags for a US$20 reward. In order to receive the reward, anglers were required to submit the tag, catch date, and state whether the fish was harvested or released. Postage-paid envelopes with required angler catch information were available at lake concession facilities, VDGIF offices, and local tackle shops.

Catch rate for this study included the number of fish caught regardless of fate (harvested or released). Annual catch rate was calculated as the number of tags returned each year divided by the total number of fish tagged each year. At least 10% of the fish tagged at each study site were double tagged annually to estimate tag loss (Miranda et al. 2002). Tag retention was calculated from the proportion of double tagged fish caught by anglers that lost and retained tags (Muoneke 1992). Angler survey cards were used to estimate non-reporting (Zale and Bain 1994). Thirty postage-paid postcards were handed to anglers fishing at each study area each year. The postcards contained five multiple-choice questions, a space for the angler's return address, and a statement that a reward of $20 was offered for the return of the card. The proportion of postcards returned each year was used to estimate response rate. Adjusted annual catch rate (C_{adj}) was calculated by the equation:

$$C_{adj} = \text{annual catch rate}/(\text{tag retention} \times \text{response rate})$$

Annual harvest rates were only determined from the catch information provided by anglers with tag returns that indicated whether the fish was harvested or released. Annual harvest rates were calculated as the proportion harvested. Adjusted annual catch rates and harvest rates were used to estimate annual exploitation (u) by the equation:

$$u = C_{adj} \times \text{annual harvest rate}$$

For study sites with minimum length limit regulations in place we compared annual catch, harvest, and exploitation of legal-sized fish to other non-restrictive waters.

Minitab Statistical Software Release 12 was used for data analyses and statistical tests. ANOVA was used to test for significant differences among study sites and years. Significant differences were analyzed with a Fisher's pairwise comparison test. All statistical tests were conducted at $\alpha = 0.05$.

Table 1. Number of walleye tagged, number of tagged walleye returned by anglers (Returned), adjusted catch rate (C_{adj}), harvest rate, and exploitation rate (u) in seven Virginia waterbodies during 2008–2011. Waterbody types were River (R), Small Impoundment (SI), and Large Impoundment (LI). Mean (± SD) C_{adj}, harvest, and exploitation rates with the same superscripts were similar (Fisher's pairwise comparison test, $P > 0.05$).

Waterbody	Type	Year	Number tagged	Number returned	Catch rate	C_{adj} rate	Harvest rate (%)	*u* (%)
New River	R	2008	101	19	19	29	26	8
		2009	100	24	24	37	17	6
		2010	100	16	16	25	6	2
		2011	300	34	11	17	12	2
		Mean				$27^{bc} \pm 8$	$15^{d} \pm 8$	$4^{c} \pm 3$
Lake Brittle	SI	2008	91	24	26	41	50	20
		2009	105	24	23	35	33	12
		2010	100	17	17	26	18	5
		2011	105	22	21	32	5	2
		Mean				$33^{b} \pm 6$	$27^{cd} \pm 19$	$10^{bc} \pm 8$
South Holston	LI	2008	250	46	18	28	65	18
		2009	250	41	16	25	88	22
		2010	250	40	16	25	70	17
		Mean				$26^{bc} \pm 2$	$74^{a} \pm 12$	$19^{a} \pm 3$
Hungry Mother	SI	2008	100	20	20	31	45	14
		2009	60	10	17	26	80	21
		2010	100	18	18	27	61	17
		Mean				$28^{bc} \pm 3$	$6^{2ab} \pm 18$	$17^{ab} \pm 3$
Orange	SI	2010	102	19	19	29	68	20
		2011	50	10	20	31	20	6
		Mean				$30^{bc} \pm 1$	$44^{bc} \pm 34$	$13^{abc} \pm 10$
Philpott	LI	2009	249	25	10	15	52	8
		2010	250	27	11	17	52	9
		2011	258	34	13	20	56	9
		Mean				$17^{c} \pm 2$	$53^{ab} \pm 2$	$9^{bc} \pm 0$
Whitehurst	SI	2008	90	18	20	31	33	10
		2009	105	42	40	61	48	29
		Mean				$46^{a} \pm 22$	$41^{bcd} \pm 11$	$20^{a} \pm 14$

Results

A total of 3116 walleye were tagged across all water bodies during the course of this study (Table 1). Tags were returned from 530 of these tagged fish, and 73 of those were double tagged. Because the number of double-tagged fish caught at each study site each year was low (0 to 12 fish), we pooled annual tag loss data and calculated an overall mean. The overall mean tag loss (12%, SD = 3) was used to adjust annual catch rates.

Non-response rates ranged from 7% to 80% across locations during this study (Table 2). Site-specific, non-response rates for small impoundments varied from 37% to 80% (mean = 56%, SD = 14), and resulted in adjusted catch rates exceeding 100%. Thus, annual non-response rates from the New River and the two large impoundments, which ranged from 7% to 47% (mean 26%, SD = 17), were pooled to calculate an overall non-response rate for this study. A non-response rate of 26% was used for all waters to adjust annual catch rates.

Adjusted annual catch rates ranged from 15% to 61% (Table 1). Mean adjusted catch rates were significantly different among sites ($F = 3.2$, df = 6, $P = 0.03$) (Figure 1). Mean adjusted catch rates were higher at small impoundments (34%) than the New River (27%) or large impoundments (22%) ($F = 3.72$, df = 2, $P = 0.04$) (Figure 2). The overall mean adjusted annual catch rate for all water bodies was 29% (SD = 10).

The percentage of tagged fish that were reported as harvested varied among the different waters ($F = 5.6$, df = 6, $P = 0.004$) (Table 1). Mean harvest was also different among the three water body types ($F = 8.1$, df = 2, $P = 0.003$). Annual harvest rate was lower at the New River (mean = 15%, SD = 8), than at small impoundments (mean = 42%, SD = 23) and large impoundments (mean = 64%, SD = 14). The overall mean annual harvest was 43% (SD = 25).

Annual exploitation ranged from 2% to 29% (mean = 12%, SD = 8) (Table 1). Mean annual exploitation varied slightly across the seven study sites ($F = 2.79$, df = 6, $P = 0.053$) (Table 1, Figure 1), but was similar among the three water body types ($F = 3.05$, df = 2, $P = 0.07$). However, mean annual exploitation was more than three-fold higher at small and large impoundments than the New River. Overall mean annual exploitation was 12% (SD = 8).

Three of the study impoundments had 457-mm minimum total length limit regulations for walleye during the entire study (Hungry Mother Lake, Philpott Reservoir, and South Holston Reservoir). Adjusted annual catch rates for walleyes greater than 457 mm in these waters ranged from 13% to 36% (mean = 25%, SD = 9) (Table 3). Annual harvest rates of legal-sized tagged fish in lakes with a 457-mm minimum length limit ranged from 57% to 100% (mean = 79%, SD = 16) (Table 3). Annual harvest rates of legal sized fish in these lakes were 25% higher in the two large impoundments (mean = 85%, SD = 13) than in Hungry Mother Lake (mean = 68%, SD = 17); however, the differences were not significant ($F = 2.9$, df = 1, $P = 0.13$). Annual exploitation of legal-sized fish from regu-

Table 2. Non-response rate determined for tagged walleye caught by Virginia anglers from seven study sites, 2008–2011. Double tagged fish are denoted as DT.

Waterbody	Year	Non-response rate (%)	DT fish caught/reported	DT fish lost one tag
New River	2008	47	0	0
	2009	20	2	1
	2010	13	2	0
	2011	7	5	2
	Mean	22		
Lake Brittle	2008	56	2	0
	2009	70	2	1
	2010	80	2	0
	2011	43	2	0
	Mean	62		
South Holston	2008	10	5	3
	2009	31	6	0
	2010	7	12	2
	Mean	16		
Hungry Mother	2008	37	3	0
	2009	45	1	0
	2010	50	2	1
	Mean	44		
Orange	2010	70	3	2
	2011	43	0	0
	Mean	57		
Philpott	2009	40	2	1
	2010	37	9	0
	2011	47	9	0
	Mean	41		
Whitehurst	2008	67	1	0
	2009	60	3	0
	Mean	64		

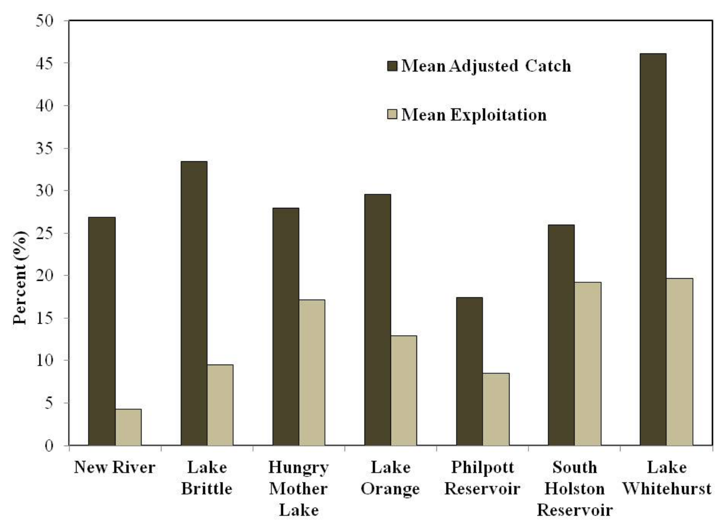

Figure 1. Mean adjusted catch and exploitation rates of walleye caught from river, large impoundment, and small impoundment sites located around Virginia from 2008–2011.

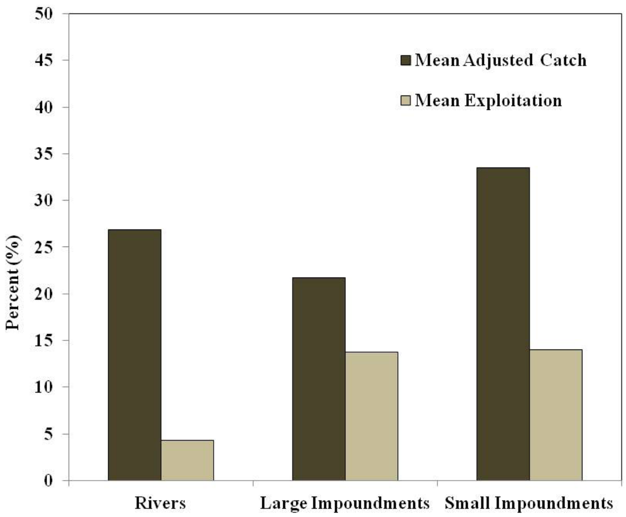

Figure 2. Mean adjusted catch and exploitation rates of walleye from seven sites located around Virginia from 2008–2011.

Table 3. Number tagged and returned, catch rate (Catch), adjusted catch rate (C_{adj}), harvest and exploitation (*u*) rates of walleyes in four populations managed with a minimum-length limit (MLL) during the entire study, 2008–2011. All were managed with a 457-mm MLL except for the New River, which was managed with a 508-mm MLL.

Waterbody	Year	Number tagged above MLL	Number returned above MLL	Catch	C_{adj}	Harvest (%)	*u* (%)
Hungry Mother	2008	59	14	0.24	0.36	58	21
	2009	38	8	0.21	0.32	88	28
	2010	75	14	0.19	0.29	57	16
Philpott	2009	147	13	0.09	0.14	100	14
	2010	170	14	0.08	0.13	71	9
	2011	141	20	0.14	0.22	70	15
South Holston	2008	184	42	0.23	0.35	80	28
	2009	210	35	0.17	0.26	97	25
	2010	217	26	0.12	0.18	92	17
New River	2008	42	8	0.19	0.29	50	15
New River	2009	17	5	0.29	0.45	75	34
New River	2010	15	2	0.13	0.20	50	10

lated impoundments ranged from 9% to 28% (mean = 19%, SD = 6) (Table 3).

A 508-mm minimum length limit was in place on the New River from 2008 through 2010. Adjusted annual catch rates for walleye greater than 508 mm ranged from 20% to 45% (mean = 32, SD = 13) (Table 3). Harvest of legal-sized fish from the New River ranged from 50% to 75% (mean = 58%, SD = 14) (Table 3), and annual exploitation ranged from 10% to 34% (mean = 20%, SD = 13) (Table 3).

The mean TL of all walleye tagged during the study was 456 mm (SD = 83). Walleye tagged in the large impoundments were larger (mean TL = 482 mm, SD = 57) than those tagged in the New River (mean TL = 465 mm, SD = 70) or small impoundments (mean TL = 413, SD = 102) ($F = 251.89$, df = 2, $P < 0.001$). The mean TL of all tagged walleye caught by anglers was 455 mm (SD = 86.5). Mean TL of angler-caught walleye was highest in large impoundments (489 mm, SD = 62), followed by the New River (465 mm, SD = 62) and small impoundments (418 mm, SD = 100) ($F = 42.7$, df = 2, $P < 0.001$) (Table 4). The mean TL of all tagged walleye harvested by anglers (491 mm, SD = 79) was higher than the mean TL of those tagged or caught ($F = 20.2$, df = 2, $P < 0.001$). Mean TL of walleye harvested from the large impoundments (509 mm, SD = 56) and the New River (507 mm, SD = 74) were higher than the mean TL of walleye harvested in the small impoundments (462 mm, SD = 98) ($F = 10.5$, df = 2, $P < 0.001$) (Table 4).

Discussion

Prior to this study, Virginia's fisheries managers had limited data on angler catch and exploitation of walleye. In this study, walleye adjusted annual catch rates varied among waterbody (range 15%–61%), with small impoundments exhibiting the highest rates and highest potential for over exploitation. Small impoundments (<200 ha) used in this study typically were shallower and habitat more limited than large impoundments and the New River, which may make walleye more accessible to anglers and more susceptible to catch. These water bodies sustain higher levels of angler usage per surface area (VDGIF 2008) and are stocked at higher rates than large impoundments increasing angler odds to catch walleye.

Exploitation during this study ranged from 2%–29%, which was similar to the range observed in a study by Baccante and Colby (1996) that compared 46 North American walleye populations. Exploitation was likely underestimated for certain waterbodies, especially in the case of small impoundments. This study used a non-reporting rate based on the average of the large impoundments and the New River (26%) to account for the number of tag returns for all waters. In some instances, specific waterbody non-reporting rates were much higher than 26% (small impoundment range = 37%–80%, mean = 56%), which resulted in some estimated catch and exploitation rates over 100%. Since catch and exploitation rates near 100% are unlikely, and neither can exceed 100%, non-reporting rates from small impoundments were likely biased high. Similar trends in low postcard response rates have been reported in other studies (Weaver and England 1986, Zale and Bain 1994, Maceina et al. 1998, Quist et al. 2010) and have been associated with low reward values and/or poor publicity. There is much uncertainty in determining angler compliance and estimates can be untrustworthy (Miranda et al. 2002). Miranda et al. (2002) summarized other methods to estimate exploitation, with all methods having significant drawbacks, and suggested that researchers might benefit by augmenting tagging studies with other metrics like fish growth, population size structure, fish condition, and annual mortality. In cases of uncertainty, researchers can use these population metrics to validate exploitation estimates (Maceina et al. 1998).

Harvest regulations represent one of the most common tools utilized by fisheries managers to manipulate walleye exploitation rates (Barton 2011), and harvest restrictions tempered exploitation of walleye populations in this study. Throughout the study, exploitation was the lowest in waters with previously established harvest restrictions, and exploitation dropped considerably (up to 90%) in all previously unregulated waters after a regulation change. Prior to the initiation of our study in 2008, walleye were regulated with a 457-mm length limit on three waters (Hungry Mother Lake, Philpott Reservoir, and South Holston Reservoir) to protect younger fish and to shift walleye harvest to larger size classes. In 2011, the 457-mm minimum length limit for walleye was expanded statewide except the New River to increase walleye size structure in all Virginia waters. To protect a genetically unique walleye stock in the New River (Palmer et al. 2007), a 483- to 711-mm protected slot with a two-fish-per-day bag limit was enacted in 2011 from February to May to protect spawning females. Walleye regulations from June to January revert to a 508-mm minimum length limit with a five per day creel. During 2008–2009, 86%–100% of all New River walleye tag returns originated during the spawning season, which validated the results of a 2007 angler survey that indicated that the majority of the fishing pressure for walleye in the New River occurred between February and April (VDGIF 2008).

Exploitation can negatively affect fish populations through growth and recruitment overfishing (Regier and Loftus 1972, Jensen 1991, Quist et al. 2010, Schmalz et al. 2011). Recruitment overfishing is of little concern in most of Virginia's walleye fisheries other than the New River walleye fishery due to populations sustained by annual stocking. During our study, mean exploitation of New River walleye was low at approximately 5%, and not at levels high enough to cause recruitment overfishing (40%–50%) (Quist et al. 2010).

However, growth overfishing is a concern in Virginia's walleye fisheries due to observed catch rates and the potential for over exploitation. Catch estimates were significantly higher in small impoundments than other waterbodies, presenting the highest potential for over exploitation. Although exploitation rates observed in this study were relatively low when compared to values associated with over exploited walleye fisheries (≥40%; Quist et al. 2010, Schmalz et al. 2011), exploitation appeared to affect size structure of walleye populations in Virginia. Population sampling data showed that the majority (85%) of walleye collected in the upper New River were less than the 508-mm minimum length limit, suggesting that anglers were removing most fish that reached legal size. Growth overfishing was most evident at Lake Brittle (harvest mean TL = 345 mm), as documented mean harvested TL at most other sites were much higher (mean TL range 481–524 mm). In addition, large specimens were absent from our Lake Brittle surveys, further suggesting that this fishery was highly impacted by anglers (VDGIF, unpublished data).

Walleye fishing pressure has increased in Virginia (Hampton 2000) and this study revealed that different populations are exploited at different levels. This indicates managers may have to utilize different strategies based on waterbody types and angler habits to maximize walleye populations. Larger water bodies in Virginia typically have large walleye populations, offering anglers the greatest opportunity to harvest walleye, and sustained annual stockings may allow managers to liberalize creel limits. However, on smaller water bodies where catch rates are higher, the impact of high exploitation on populations will need to be reduced by more stringent regulations. Additionally, Virginia's small impoundments are annually stocked with overall fewer walleye solely based on water body size. As a result, managers may have to increase stocking rates in Virginia small impoundments to maintain desired walleye populations. In an economic environment where limited resources demand the highest return on investments, fisheries managers must consider variable angler behaviors on different water body types in conjunction with biological parameters.

Acknowledgments

Funding for this project was provided through Federal Aid in Sportfish Restoration grant F-111-R. Special thanks to VDGIF biologists, conservation police officers, and technicians who assisted in field collections.

Literature Cited

Baccante, D.A. and P.J. Colby. 1996. Harvest, density, and reproductive characteristics of North American walleye populations. Annales Zoologici Fennici 33:601–615.

Barton, B. A., 2011. Biology, management, and culture of walleye and sauger. American Fisheries Society, Bethesda, Maryland.

Hampton, T. M. 2000. A comprehensive plan for stocking walleyes in Virginia impoundments. Virginia Department of Game and Inland Fisheries, Richmond, Virginia.

Isermann, D. A. and B. G. Parsons. 2011. Harvest regulations and sampling. Pages 403–422 *in* B. A. Barton, editor. Biology, management, and culture of walleye and sauger. American Fisheries Society, Bethesda, Maryland.

Jensen, A. L. 1991. Simulation of fish population responses to exploitation. Ecological Modelling 55:203–218.

Kerr, S. J. 2011. Stocking and marking: lessons learned over the past century. Pages 423–449 *in* B. A. Barton, editor. Biology, management, and culture of walleye and sauger. American Fisheries Society, Bethesda, Maryland.

Larson, S. C., B. Saul, and S. Schleiger. 1991. Exploitation and survival of black crappies in three Georgia reservoirs. North American Journal of Fisheries Management 11:604–613.

Maceina, M. J., P. W. Bettoli, S. E. Finley, and V. J. Dicenzo. 1998. Analysis of the sauger fishery with simulated effects of a minimum size limit in the Tennessee River of Alabama. North American Journal of Fisheries Management 18:66–75.

MacRitchie, I.C. and E.R. Armstrong. 1984. An incentive program to increase angler tag returns. North American Journal of Fisheries Management 4:129–130.

Miranda, L. E., R. E. Brock, and B. S. Dorr. 2002. Uncertainty of exploitation estimates made from tag returns. North American Journal of Fisheries Management 22:1358–1363.

Muoneke, M. I. 1992. Loss of floy anchor tags from white bass. North American Journal of Fisheries Management 12:819–824.

______. 1994. Dynamics of a heavily exploited Texas white bass population. North American Journal of Fisheries Management 14:415–422.

Palmer, G. C., D. Dutton, J. Williams, B. R. Murphy, N. Johnson, M. Scott, K. Finne, and E. M. Hallerman. 2007. Genetic marker-assisted restoration of the presumptive native walleye stock in the New River, Virginia and West Virginia. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 61:17–22.

Pegg, M. A., J.B. Layzer, and P. W. Bettoli. 1996. Angler exploitation of anchor-tagged saugers in the Lower Tennessee River. North American Journal of Fisheries Management 16:218–222.

Quist, M. C., J. L. Stephen, S. T. Lynott, J. M. Goeckler, and R. D. Schultz. 2010. Exploitation of walleye in a Great Plains reservoir: harvest patterns and management scenarios. Fisheries Management and Ecology 17:522–531.

Regier, H. A. and K. H. Loftus. 1972. Effects of fisheries exploitation on salmonid communities in oligotrophic lakes. Journal of the Fisheries Research Board of Canada 29:959–968.

Schmalz P. J., A. H. Fayram, D. A. Isermann, S. P. Newman, and C. J. Edwards. 2011. Harvest and exploitation. Pages 375–401 *in* B. A. Barton, editor. Biology, management, and culture of walleye and sauger. American Fisheries Society, Bethesda, Maryland.

Serns, S. L. and J. J. Kempinger. 1981. Relationship of angler exploitation to the size, age, and sex of walleyes in Escanaba Lake, Wisconsin. Transactions of the American Fisheries Society 110:216–220.

Steinkoenig, E.L. 1997. A statewide summary of sampling data for walleye in Virginia. Virginia Department of Game and Inland Fisheries Final Report for D-J Project F-111-R Study 8.

Virginia Department of Game and Inland Fisheries (VDGIF). 2008. Aquatic resource investigations annual interim report. Virginia DJ Grant F-111-R-16.

Weaver, O. R. and R. H. England. 1986. Return of tags with different rewards in Lake Lanier, Georgia. North American Journal of Fisheries Management 6:132–133.

Zale, A. V. and M. B. Bain. 1994. Estimating tag-reporting rates with postcards as tag surrogates. North American Journal of Fisheries Management 14:208–211.