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An Update to Pennsylvania's Inland Walleye Management Plan

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Pennsylvania Fish and Boat Commission, Division of Fisheries Management

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Introduction

The Pennsylvania Fish and Boat Commission (PFBC) has a goal to provide management programs that supply consistent opportunities to catch Walleyes within compatible habitats across the Commonwealth. To realize that goal, the PFBC published its initial *Walleye Plan for Pennsylvania* in 1988 (Hoopes and Young 1988). This plan was updated in 2011 and titled *A Plan for the Management of Pennsylvania's Inland Walleye Fisheries* (PFBC 2011). Henceforth, these plans are referred to as the 1988 Walleye Plan and the 2011 Walleye Plan. Additionally, the scope of these plans and subsequent updates only pertains to inland fisheries and does not include the Lake Erie Walleye fishery. This document updates previous plans and serves as a mechanism to: 1) evaluate the efficacy of objectives outlined in previous plans and the level to which they were achieved; 2) address new issues in Walleye management; and 3) provide a status update regarding Walleye management in Pennsylvania. This update includes data collected through 2020 and some preliminary data from 2021.

Objectives Identified in Previous Plans and Updates

- **Objective 1. Develop reliable techniques to determine the contribution of stocked Walleyes to survey catches and fisheries.**

  - **Strategy 1. Use Oxytetracycline (OTC) tagging of Walleye fingerlings to determine hatchery contribution to fall survey catches of young-of-year (YOY) Walleyes.**

    Progress: PFBC hatcheries have demonstrated the ability to reliably apply OTC tags to Walleye fingerlings which are identifiable by Division of Fisheries Management (DFM) and Division Fish Production Services (FPS) staff in YOY Walleyes collected during field sampling.

  - **Strategy 2. Use OTC tagging of Walleye fingerlings to determine hatchery contribution to survey catches of adult Walleyes.**

    Progress: PFBC hatcheries have demonstrated the ability to reliably apply OTC tags to Walleye fingerlings which are identifiable by DFM and FPS staff in adult Walleyes up to Age 6 collected during field sampling.

  - **Strategy 3. Use OTC tagging of Walleye fry to determine hatchery contribution to fall survey catches of YOY Walleyes.**

    Progress: Despite previous successes, there have been difficulties in the application of OTC tags to Walleye fry and subsequent tag detection in YOY Walleyes collected during field sampling. In 2012, multiple river sections were returned to the Walleye stocking program and were stocked annually with OTC tagged fry. Between 2012 and 2017, almost no YOY Walleyes tagged as fry were identified in collections, despite increased survey catch-per-unit-effort (CPUE) coinciding with reinstitution of stocking, suggesting that many of these fish could have been of hatchery origin.

Due to efforts detailed below, among others, by the Bureau of Hatcheries (BOH), FPS, and the DFM, most of the tag detection problems in Walleyes tagged as fry were resolved.

- OTC tags were applied to Walleye fry in heated water at the Pleasant Mount State Fish Hatchery (SFH) after it was determined that slow growth associated with colder water temperatures was inhibiting uptake of the OTC into the otoliths, which adversely affected the presence and quality of the tags.

- FPS purchased a new microscope and light source to better detect OTC tags.

- OTC tagging and reading techniques were tested. Walleye fry were OTC tagged and grown out in hatchery ponds at Pleasant Mount SFH and Linesville SFH and harvested in the fall to simulate the timing of DFM surveys. Another sample of YOY Walleyes was collected from Pymatuning Reservoir during fall nighttime boat electrofishing and were known to be untagged. The otolith technician was given a random mix of these known fry tagged and known untagged YOY Walleyes. The otolith technician correctly identified the fry tags in 100% of the Pleasant Mount fish (30 of 30) and 97% (29 of 30) of the Linesville fish. They also correctly identified all Pymatuning Reservoir fish (30 of 30) as untagged.

- In 2017, several YOY Walleyes collected in the Juniata and Susquehanna rivers had both fry and fingerling OTC tags, which verified that staff could detect fry OTC tags in YOY Walleyes collected in the wild.

- A large portion of the YOY collected from Pymatuning Sanctuary exhibited easily detectable OTC fry tags.

We now have confidence in our ability to apply OTC tags to Walleye fry and to detect those tags in YOY Walleyes collected during field sampling. Evaluation of the river sections remaining in the Walleye fry stocking program continued through 2020 utilizing OTC tags applied to fry to determine the contribution of stocked fry to the wild Walleye population in each river section.

In the future, should OTC marking of Walleye fry not be the preferred technique to determine hatchery contribution of Walleyes stocked as fry to fisheries, the PFBC has begun investigation of alternative assessment methods (see Objective 5, Strategy 1).

- **Strategy 4. Standardize sampling techniques pertaining to gear used, survey timing (e.g., spring or fall), and effort expended.**

Progress: No changes in sampling gears or sample timing are anticipated at this time as gear and techniques used have been assessed and refined as needed to ensure maximum survey efficiency. Our current options of Pennsylvania-style trap nets, monofilament gill nets consisting of appropriate designs and mesh sizes, and nighttime boat electrofishing conducted according to methods outlined in the 1988 Walleye Plan and 2011 Walleye Plan are efficient and effective means to collect data necessary to inform management decisions. While increased sampling effort may be desired at some waters, the current

level of effort expended considers survey logistics and staffing levels to maximize efficiency while collecting data necessary to adequately inform management decisions.

- **Objective 2. Determine which waters can meet management objectives and produce directed fisheries based on natural reproduction and eliminate these waters from the Walleye stocking program.**

  - **Strategy 1. Area Fisheries Managers (AFMs) will determine the presence or absence of Walleye natural reproduction, and in those waters where natural reproduction occurs, evaluate if natural reproduction is sufficient to sustain a high-quality fishery.**

    Progress: This evaluation was primarily associated with Pennsylvania's major rivers and began with the cessation of Walleye stocking in all flowing waters in 2007. One of the primary goals of the 2011 Walleye Plan was to determine the contribution from natural reproduction to riverine Walleye fisheries in the absence of stocking.

    AFMs sampled formerly stocked river sections targeting both YOY and adult Walleyes to determine the level of natural reproduction that existed in the absence of stocking. For these waters, sampling has been completed and the presence/absence of Walleye natural reproduction determined. These results informed management decisions and formerly stocked river sections were placed into one of three categories: 1) waters with Walleye fisheries maintained through natural reproduction, 2) waters returned to the Walleye stocking program to restore or maintain their fisheries, and 3) waters no longer managed as Walleye fisheries. The results of these evaluations and management decisions were published on the PFBC's website (PFBC 2014) and are summarized in Table 1. River sections returned to the Walleye stocking program have been evaluated for the contribution of hatchery fry to wild populations. Procedures and results are detailed in Objective 3, Strategy 1.

    Table 1. Management decisions pertaining to formerly stocked river sections.

Water	Section	Management
Allegheny River	7	Resumed stocking
Allegheny River	8	Resumed stocking
Allegheny River	9	Resumed stocking
Allegheny River	10	Natural reproduction
Allegheny River	11	Natural reproduction
Allegheny River	12	Natural reproduction
Allegheny River	13	Natural reproduction
Allegheny River	14	Natural reproduction
Allegheny River	15	Natural reproduction
Allegheny River	16	Natural reproduction
Allegheny River	17	Natural reproduction
French Creek	3	Resumed stocking
French Creek	4	Resumed stocking
French Creek	5	Resumed stocking
French Creek	6	Resumed stocking

Water	Section	Management
Susquehanna River	1	Natural reproduction
Susquehanna River	2	Natural reproduction
Susquehanna River	3	Resumed stocking
Susquehanna River	4	Resumed stocking
Juniata River	1	Natural reproduction
Juniata River	2	Natural reproduction
Juniata River	3	Resumed stocking
Juniata River	4	Resumed stocking
Lehigh River	7	No longer managed for Walleye
Lehigh River	8	No longer managed for Walleye
Lehigh River	9	No longer managed for Walleye
Delaware River	4	Natural reproduction
Delaware River*	5	Natural reproduction
Delaware River*	6	Natural reproduction

* Portions of the Delaware River are annually stocked with fingerling Walleyes by the State of New Jersey through dedicated and excess production of Walleyes.

Progress: Less effort has been directed towards describing natural reproduction in our lakes and reservoirs because the status of natural reproduction in most of these waters has already been determined as outlined in the 2011 Walleye Plan.

Several reservoirs managed as self-sustaining Walleye fisheries with no stocking were recently surveyed and found to contain very old Walleyes which were likely the remnants of historic stocking efforts. Subsequently, these waters were returned to the stocking program and all fingerlings stocked were OTC marked. Ongoing and future evaluations will determine if these populations are sustained through natural reproduction or require maintenance stocking.

The DFM had an opportunity to further evaluate natural reproduction in our lakes and reservoirs. Walleye fingerling requests exceeded production for the years 2015 through 2017. As such, many waters in the Walleye fingerling stocking program were not stocked on an annual basis. Twenty-seven waters in the Walleye fingerling stocking program did not receive Phase 1 (PH1) fingerlings in 2017. Additionally, 24 of those 27 also did not receive PH1s in 2016. If AFMs suspected natural reproduction of Walleyes in these waters, they were directed to sample these waters for yearling Walleyes during spring 2018. Spring nighttime boat electrofishing for yearling Walleyes, two to four weeks after the completion of spawning, has proven to be an effective measure of recruitment (Copeland 1998, Hansen 2000). Two waters were sampled in 2018 (Duck Harbor Pond and Falls Township Park Pond) and no YOY Walleyes attributable to natural reproduction were captured. Currently, the strategy to assess natural reproduction of Walleyes in lakes and reservoirs is to stock OTC marked fingerlings during spring and conduct fall nighttime boat electrofishing to collect a sample of YOY Walleyes and analyze for OTC marks. Substantial numbers of untagged YOY Walleyes provides evidence of natural reproduction.

- **Objective 3. When consistent Walleye stocking fails to produce a targeted Walleye fishery, Walleye stocking will be discontinued.**

  Primary reasons to justify Walleye stocking include: 1) to establish naturally reproducing populations in waters where Walleyes do not exist, 2) to restore natural reproduction in waters where native populations were lost or diminished, 3) to enhance the quality of the fisheries with supplemental stockings in waters where natural reproduction is insufficient to support high-quality fisheries, 4) to create put-grow-and-take fisheries through repeated maintenance stockings, and 5) to supplement existing or establish new Walleye populations at levels sufficient to act as a biological control agent of other species and influence fish community structure (Kerr 2011; MN DNR 1996).

  Across North America, many efforts to introduce or re-establish reproducing Walleye populations have been successful (Barton 2011). In Pennsylvania, introductions in the Susquehanna and Delaware river systems have produced multiple naturally reproducing populations ranging from low to high density. New introductions in several small and major river sections may establish self-sustaining populations (see Strategy 3 below). New opportunities to introduce or re-establish Walleyes in Pennsylvania waters includes rivers fragmented by dams or where poor water quality prevents existing Walleye populations from colonizing upstream areas, such as the Beaver and West Branch Susquehanna rivers.

  Conversely, across North America, most supplemental stockings over naturally reproducing Walleye populations, which were intended to increase Walleye year class strength and the quality of fisheries, have not produced the desired result (Li et al. 1996; Reed and Staples 2017). In Pennsylvania, most Walleye fry stockings in our major rivers were intended to supplement naturally reproduction. The evaluation of these stockings is complete (see Strategy 2 below). The stocking of Walleyes in one reservoir (Allegheny Reservoir) is currently considered supplemental and it is currently under evaluation.

  Walleye stocking is not currently used as a biological control strategy in Pennsylvania because naturally reproducing populations of Largemouth Bass adequately serve that function. However, in a few waters stocked to create put-grow-and-take Walleye fisheries, biological control of stunted panfish or over abundant forage fish may be realized through Walleye stocking.

  The purpose for almost all the Walleye stocking in Pennsylvania, and in some adjacent jurisdictions, is to establish put-grow-and-take fisheries. Virtually all current lake and reservoir Walleye fingerling stocking is to establish put-grow-and-take fisheries. As such, it is important that the PFBC maximize the use of a limited supply of Walleye fingerlings and fry to ensure that stocking creates high-quality fisheries.

- **Strategy 1. Evaluate the four Large Reservoirs remaining in the Walleye fry stocking program.**

  Progress: The number of lentic waters remaining in the Walleye fry stocking program was reduced to four (Table 2). These waters will be stocked with OTC tagged fry to facilitate the evaluation of the contribution of hatchery fish to the Walleye population.

An additional benefit will be to further evaluate efforts to improve tagging Walleye fry with OTC and detecting those tags in fall YOY. Evaluations of fry stocking in Pymatuning Reservoir and Pymatuning Sanctuary were evaluated with OTC tagged Walleyes and both waters will remain in the fry stocking program. Evaluation of the Allegheny Reservoir is ongoing. Repairs to the East Branch Clarion River Lake dam were completed and the reservoir pool was restored in 2020. Walleye fry stocking evaluation will commence in 2022.

Table 2. Waters remaining in the Walleye fry stocking program.

Water	Number of fry	Years
Pymatuning Reservoir	4,000,000	1981 – 2021
Pymatuning Sanctuary	1,875,000	1985 – 2021
Allegheny Reservoir	6,000,000	1975 - 2021
East Branch Clarion River Lake	1,000,000	1976 - 2021

- **Strategy 2. Evaluate river sections returned to the Walleye stocking program.**

As stated previously in Objective 2, Strategy 1, the following river sections were returned to the Walleye stocking program: Allegheny River, sections 07 – 09; French Creek, sections 03 – 06; Susquehanna River, sections 03 – 04; and Juniata River, sections 03 – 04. The evaluation to determine the contribution of stocked Walleyes to their fisheries has been completed for all of these rivers. In addition, Allegheny River, Section 10, and Susquehanna River, Section 05, were also evaluated to determine if stocked Walleyes drifted downstream into the unstocked sections and established fisheries.

Progress: Flowing waters returned to the Walleye stocking program followed protocols outlined in the 2011 Walleye Plan. AFMs concurrently stocked OTC tagged Walleye fry and PH1 fingerlings with life stage-specific marks and conducted investigations to determine each life stage's respective contribution to fisheries. However, results of this evaluation were confounded by the following issues: 1) there were insufficient numbers of Walleye fingerlings available to meet all stocking requests, 2) OTC tags may not have been consistently retained by Walleyes tagged as fry, 3) tags on Walleyes believed to be tagged as fry may not have been accurately detected, and 4) increases in assessment catch rates during stocking periods compared to non-stocking periods in rivers were not accompanied by an increased number of OTC marked Walleyes.

Despite these issues, progress was made towards informing management decisions on these river sections. As described in Objective 1, Strategy 3, difficulties regarding OTC tag retention in Walleye fry were resolved. With restored confidence in OTC tagged Walleye fry, Walleye sampling in 2018, 2019, and 2020 reinforced the results from previous years sampling because very few OTC tagged YOY Walleyes were captured regardless of YOY catch rates. River sections returned to the Walleye stocking program, recent stocking history, and recent survey results are presented in Tables 3 - 12. Following sampling in 2019 and 2020~~)~~, enough data were collected to make informed management decisions for all stocked river sections. The Susquehanna, Juniata, and Allegheny rivers and French Creek were removed from the Walleye fry stocking program and are currently being managed as fisheries sustained through natural reproduction.

Respective AFMs have established annual index sites and will continue to monitor these rivers for YOY and adult Walleye relative abundance.

Table 3. History of Walleye stocking and Walleye sampling results in the Allegheny River, Section 07, 2005 – 2021.

Year	Number of fry stocked	YOY* CPUE (#/hour)	% YOY stocked	% YOY wild	Age 1+ CPUE (#/hour)
2005	350,000	Not surveyed	-	-	-
2006	350,000	Not surveyed	-	-	-
2007	350,000	Not surveyed	-	-	-
2008	No stocking	Not surveyed	-	-	-
2009	No stocking	Not surveyed	-	-	-
2010	No stocking	11.2	0	100	**20.8**
2011	No stocking	14.8	0	100	**59.2**
2012	No stocking	10.0	0	100	**42.0**
2013	No stocking	4.3	0	100	**23.1**
2014	No stocking	Not surveyed	-	-	-
2015	566,000	**23.2**	0	100	**67.6**
2016	566,000	**31.6**	0	100	**18.9**
2017	566,000	16.0	0	100	**41.0**
2018	566,000	**21.6**	0	100	**17.5**
2019	566,000	**25.0**	0	100	**28.0**
2020	No stocking	Not surveyed	-	-	-
2021	No stocking	Not surveyed	-	-	-

*Walleyes < 200 mm were considered YOY unless ages were assigned via scale analysis.

Values in bold text represent survey results that achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+ CPUE ≥ 10/hour) of the 2011 Walleye Plan.

Table 4. History of Walleye stocking and Walleye sampling results in the Allegheny River, Section 08, 2005 – 2021.

Year	Number of fry stocked	YOY* CPUE (#/hour)	% YOY stocked	% YOY wild	Age 1+ CPUE (#/hour)
2005	300,000	Not surveyed	-	-	-
2006	300,000	Not surveyed	-	-	-
2007	300,000	Not surveyed	-	-	-
2008	No stocking	Not surveyed	-	-	-
2009	No stocking	Not surveyed	-	-	-
2010	No stocking	Not surveyed	-	-	-
2011	No stocking	Not surveyed	-	-	-
2012	No stocking	Not surveyed	-	-	-
2013	No stocking	4.6	0	100	**12.0**
2014	No stocking	Not surveyed	-	-	-
2015	672,000	**68.5**	0	100	**18.5**
2016	672,000	**128.7**	0	100	**17.6**
2017	672,000	**67.0**	0	100	**37.0**
2018	672,000	**157.0**	0	100	9.0
2019	672,000	**68.0**	0	100	**12.0**
2020	No stocking	**103.0**	0	100	5.0
2021	No stocking	Not surveyed	-	-	-

*Walleyes < 200 mm were considered YOY unless ages were assigned via scale analysis.

Values in bold text represent survey results that achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour) in the 2011 Walleye Plan.

Table 5. History of Walleye stocking and Walleye sampling results in the Allegheny River, Section 09, 2005 – 2021.

Year	Number of fry stocked	YOY* CPUE (#/hour)	% YOY stocked	% YOY wild	Age 1+ CPUE (#/hour)
2005	2,630,000	Not surveyed	-	-	-
2006	2,630,000	Not surveyed	-	-	-
2007	2,630,000	Not surveyed	-	-	-
2008	No stocking	0	-	-	**10.2**
2009	No stocking	8.2	0	100	**23.6**
2010	No stocking	4.2	0	100	8.5
2011	No stocking	0	-	-	**12.0**
2012	No stocking	0	-	-	1.7
2013	No stocking	**27.9**	0	100	8.7
2014	No stocking	**62.5**	0	100	6.5
2015	3,764,000	**55.0**	0	100	6.5
2016	3,764,000	**77.9**	0	100	4.3
2017	3,764,000	**70.0**	0	100	7.0
2018	3,764,000	**245.0**	0	100	**17.0**
2019	3,764,000	**150.0**	0	100	3.0
2020	No stocking	**108.7**	0	100	4.7
2021	No stocking	8.0	0	100	5.3

*Walleyes < 200 mm were considered YOY unless ages were assigned via scale analysis.

Values in bold text represent survey results that achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour) in the 2011 Walleye Plan.

Table 6. History of Walleye stocking and Walleye sampling results in the Allegheny River, Section 10, 2005 – 2021.

Year	Walleye stocked	YOY* CPUE (#/hour)	% YOY stocked	% YOY wild	Age 1+ CPUE (#/hour)
2005	1,225,000 fry	10.3^	-	-	0.9^
2006	1,225,000 fry	0^	-	-	1.9^
2007	1,225,000 fry	0^	-	-	2.1^
2008	No stocking	0	-	-	0
2009	No stocking	14.5	0	100	4.8
2010	No stocking	**32.3**	0	100	9.5
2011	No stocking	8.6	0	100	**18.1**
2012	No stocking	0	-	-	3.7
2013	No stocking	2.0	0	100	3.0
2014	No stocking	5.4	0	100	3.3
2015	Upstream sections stocked	**42.0**	0	100	2.0
2016	Upstream sections stocked	**22.0**	0	100	**11.0**
2017	Upstream sections stocked	12.0	0	100	4.0
2018	Upstream sections stocked	**60.0**	0	100	**32.0**
2019	Upstream sections stocked	**33.0**	0	100	0.0
2020	No stocking	Not surveyed	-	-	-
2021	No stocking	Not surveyed	-	-	-

*Walleyes < 200 mm were considered YOY.

^CPUE values are from surveys targeting Smallmouth Bass and may not be accurate representations of Walleye abundance.

Values in bold text represent survey results that achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour) in the 2011 Walleye Plan.

Table 7. History of Walleye stocking and Walleye sampling results in French Creek, Section 04, 2010 – 2021.

Year	Number of fry stocked	YOY* CPUE (#/hour)	% YOY stocked	% YOY wild	Age 1+ CPUE (#/hour)
2010	100,000	Not surveyed	-	-	-
2008	100,000	Not surveyed	-	-	-
2009	100,000	**27.5**	N/A	N/A	4.0
2010	No stocking	9.0	0	100	4.0
2011	No stocking	0	-	-	2.5
2012	No stocking	0	-	-	5.0
2013	No stocking	Not surveyed	-	-	-
2014	No stocking	1.0	0	100	2.0
2015	1,152,000	**45.0**	0	100	**10.0**
2016	1,152,000	18.0	0	100	3.5
2017	1,152,000	0	-	-	2.0
2018	1,152,000	Not surveyed	-	-	-
2019	1,152,000	14.5	0	100	0.5
2020	1,152,000	0	-	-	1.0
2021	No stocking	3.5	0	100	3.5

*Walleyes < 200 mm were considered YOY.

Values in bold text represent survey results that achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour) in the 2011 Walleye Plan.

Table 8. History of Walleye stocking and Walleye sampling results in the Susquehanna River, Section 03, 2005 – 2021.

Year	Number of fry stocked	Number of PH1 stocked	YOY* CPUE (#/hour)	% YOY stocked as fry	% YOY stocked as PH1	% YOY wild	Age 1+ CPUE (#/hour)	Legal Walleye CPUE (≥ 15 in./hour)
2005	14,107,500	0	**19.5**	-	-	-	1.5	1.2
2006	9,664,500	0	**16.5**	-	-	-	8.1	**2.1**
2007	10,443,000	0	**36.6**	-	-	-	**10.5**	**10.8**
2008	0	0	**18.4**	0	0	100	**12.9**	**4.3**
2009	0	0	6.7	0	0	100	6.9	**4.3**
2010	0	0	**31.0**	0	0	100	7.4	**2.7**
2011	0	0	Not surveyed	-	-	-	-	-
2012	0	0	7.6	0	0	100	1.9	**2.2**
2013	19,000,000	0	7.7	-	-	-	1.0	1.4
2014	19,000,000	379,940	**43.2**	7	10	82	6.8	**3.6**
2015	19,000,000	0	**32.9**	0	0	100	**12.4**	**5.2**
2016	19,000,000	190,000	**58.2**	0	17	83	6.3	**3.5**
2017	19,000,000	190,000	1.8	0	75	25	3.6	**11.1**
2018	19,000,000	0	**86.5**	0	0	100	1.4	1.4
2019	19,000,000	0	6.3	0	0	100	5.8	1.2
2020	None	None	0.0	N/A	N/A	N/A	2.8	**2.2**
2021	None	None	Not surveyed	-	-	-	-	-

*Walleyes < 300 mm were considered YOY.

Values in bold text represent survey results achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour and/or legal Walleye CPUE ≥ 2/hour) in the 2011 Walleye Plan.

Table 9. History of Walleye stocking and Walleye sampling results in the Susquehanna River, Section 04, 2005 – 2021.

Year	Number of fry stocked	Number of PH1 stocked	YOY* CPUE (#/hour)	% YOY stocked as fry	% YOY stocked as PH1	% YOY wild	Age 1+ CPUE (#/hour)	Legal Walleye CPUE (≥ 15 in./hour)
2005	3,021,249	0	Not surveyed	-	-	-	-	-
2006	3,021,250	0	Not surveyed	-	-	-	-	-
2007	3,021,250	0	Not surveyed	-	-	-	-	-
2008	0	0	Not surveyed	-	-	-	-	-
2009	0	0	Not surveyed	-	-	-	-	-
2010	0	0	Not surveyed	-	-	-	-	-
2011	0	0	Not surveyed	-	-	-	-	-
2012	0	0	Not surveyed	-	-	-	-	-
2013	1,400,000	0	**33.0**	N/A	N/A	N/A	1.5	1.5
2014	1,400,000	19,542	**238.0**	8	4	88	9.2	**2.0**
2015	1,400,000	0	**109.0**	0	0	100	4.0	**12.0**
2016	1,400,000	14,000	**68.2**	0	45	55	5.9	**2.4**
2017	1,400,000	14,000	6.0	0	100	0	6.0	**2.0**
2018	1,400,000	0	Not surveyed	-	-	-	-	-
2019	1,400,000	0	**58.9**	0	0	100	5.5	0.0
2020	0	0	3.6	N/A	N/A	100	2.7	1.8
2021	0	0	Not Surveyed	-	-	-	-	-

*Walleyes < 300 mm were considered YOY.

Values in bold text represent survey results achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour and/or legal Walleye CPUE ≥ 2/hour) in the 2011 Walleye Plan.

Table 10. History of Walleye stocking and Walleye sampling results in the Susquehanna River, Section 05, 2005 – 2021.

Year	Number of fry stocked	Number of PH1 stocked	YOY* CPUE (#/hour)	% YOY stocked as fry	% YOY stocked as PH1	% YOY wild	Age 1+ CPUE (#/hour)	Legal Walleye CPUE (≥ 15 in./hour)
2005	0	0	12.7	-	-	-	0.6	0.6
2006	0	0	19.4	-	-	-	0.9	0.0
2007	0	0	**108.3**	-	-	-	3.6	0.5
2008	0	0	**20.9**	0	0	100	**41.8**	0.0
2009	0	0	**41.9**	0	0	100	7.1	1.9
2010	0	0	**23.8**	0	0	100	3.7	0.4
2011	0	0	0.5	0	0	100	2.6	1.5
2012	0	0	**27.2**	0	0	100	1.4	1.4
2013	0	0	**29.5**	-	-	-	**16.4**	**6.0**
2014	0	0	**44.8**	7	14	79	**10.9**	**2.2**
2015	0	0	**36.8**	0	7	93	**10.3**	**1.3**
2016	0	0	12.6	0	28	72	**16.5**	**2.2**
2017	0	0	6.2	0	79	21	**17.4**	**5.8**
2018	0	0	10.55	0	0	100	1.32	0.7
2019	0	0	**29.7**	0	0	100	7.1	1.2
2020	0	0	Not surveyed	-	-	-	-	-
2021	0	0	Not surveyed	-	-	-	-	-

*Walleyes < 300 mm were considered YOY.

Values in bold text represent survey results that achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour and/or legal Walleye CPUE ≥ 2/hour) in the 2011 Walleye Plan.

Table 11. History of Walleye stocking and Walleye sampling results in the Juniata River, Section 03, 2005 – 2021.

Year	Number of fry stocked	Number of PH1 stocked	YOY* CPUE (#/hour)	% YOY stocked as fry	% YOY stocked as PH1	% YOY wild	Age 1+ CPUE^ (#/hour)	Legal Walleye CPUE (≥ 15 in./hour)
2005	0	0	0	-	-	-	1.3	1.3
2006	0	5,500	0	-	-	-	**26.5**	**4.4**
2007	0	5,500	0.9	-	-	-	**11.3**	**2.6**
2008	0	0	0	0	0	0	5.7	**2.9**
2009	0	0	0	0	0	0	2.8	**2.8**
2010	0	0	0	0	0	0	**10.0**	**9.0**
2011	0	0	0	0	0	0	6.5	**4.8**
2012	0	0	0	0	0	0	2.2	**2.2**
2013	0	0	0	0	0	0	5.7	**3.8**
2014	0	6,000	0	0	0	0	8.2	**8.2**
2015	600,000	0	6.3	0	0	100	7.5	**5.0**
2016	600,000	6,000	0	0	0	0	2.6	1.3
2017	600,000	6,000	0	0	0	0	5.0	**5.0**
2018	600,000	0	Not surveyed	-	-	-	-	-
2019	600,000	0	Not surveyed**		-	100	-	-
2020	0	0	Not surveyed***		-	-	9.8	**8.4**
2021	0	0	0	-	-	-	9.7	**9.7**

*Walleyes < 250 mm were considered YOY.

**Three Walleye collected during Smallmouth Bass sampling assigned to wild origin based on OTC results.

*** Seven Walleye collected during Smallmouth Bass sampling of undetermined origin.

^CPUE values are from surveys targeting habitat preferred by YOY Walleyes or from surveys targeting Smallmouth Bass and may not be accurate representations of adult Walleye abundance.

Values in bold text represent survey results achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour and/or legal Walleye CPUE ≥ 2/hour) in the 2011 Walleye Plan.

Table 12. History of Walleye stocking and Walleye sampling results in Juniata River, Section 04, 2005 – 2021.

Year	Number of fry stocked	Number of PH1 stocked	YOY* CPUE (#/hour)	% YOY stocked as fry	% YOY stocked as PH1	% YOY wild	Age 1+ CPUE^ (#/hour)	Legal Walleye CPUE (≥ 15 in./hour)
2005	0	0	1.1	-	-	100	2.2	**2.2**
2006	0	26,000	0	-	-	0	1.6	1.6
2007	0	22,729	0	-	-	0	6.1	**2.0**
2008	0	26,000	0.7	0	0	100	2.6	1.3
2009	0	0	0	0	0	0	6.0	**5.7**
2010	0	0	0.5	0	0	100	0.5	0.5
2011	0	0	0	0	0	0	8.7	**6.3**
2012	0	0	0	0	0	0	2.4	**2.4**
2013	0	0	0.7	0	0	100	2.1	1.7
2014	0	40,000	**17.2**	0	95	5	5.4	**5.4**
2015	4,000,000	40,000	8.0	0	0	100	3.5	**2.5**
2016	4,000,000	40,000	5.5	0	100	0	5.0	**3.4**
2017	4,000,000	40,000	0	0	0	0	7.1	**6.5**
2018	4,000,000	0	Not surveyed	-	-	-	-	-
2019	4,000,000	0	4.3	0	0	100	1.7	0.3
2020	0	0	0.9	0	0	100	0.9	0.9
2021	0	0	0	-	-	-	7.5	**7.5**

*Walleyes < 250 mm were considered YOY.

^CPUE values are from surveys targeting habitat preferred by YOY Walleyes or from surveys targeting Smallmouth Bass and may not be accurate representations of adult Walleye abundance.

Values in bold text represent survey results achieved catch rate guidelines (YOY CPUE ≥ 20/hour and/or Age 1+CPUE ≥ 10/hour and/or legal Walleye CPUE ≥ 2/hour) in the 2011 Walleye Plan.

- **Strategy 3. Prioritize underperforming waters (Last Chance) for final assessment to meet minimum catch criteria to determine continuance in the Walleye stocking program.**

  Progress: The 2011 Walleye Plan classified 21 Large and Medium Reservoirs as Last Chance waters and prioritized them for Walleye stocking evaluations by 2016. These waters were required to meet assessment catch rate criteria established in the 2011 Walleye Plan to remain in the fingerling stocking program. Evaluations were completed and waters that did not meet criteria were removed from the Walleye stocking program. Of the 21 waters categorized as Last Chance, 15 waters did not achieve 2011 Walleye Plan catch rate guidelines and stocking was discontinued, four waters met catch rate criteria and remain in the Walleye stocking program, one water (Tamarack Lake) was recently refilled and Walleye stocking resumed in 2021, and one water (Lower Woods Pond) is currently drawn down and stocking will be resumed when the lake is refilled (Table 13).

  Walleye population assessments were not restricted to Last Chance waters. Evaluations of some waters designated as Priority and Stable in the 2011 Walleye Plan were also conducted. Of the 23 waters designated as Priority in the 2011 Walleye Plan, nine were removed from the Walleye stocking program due poor survival of stocked Walleyes, one water (Curwensville Reservoir) was removed from the stocking program to be managed through natural reproduction, one water was drained for dam repairs (Meadow Grounds Lake) with Walleye stocking to resume in 2022, and one water (Kyle Lake) was drained for dam repairs and was refilled in 2019 but is no longer managed with Walleye stocking. The remaining Priority waters continue to be stocked with Walleye fingerlings. Additionally, of the 23 waters designated as Stable waters, one water (Lake Somerset) was drained for dam repairs and Walleye stocking will resume in 2022, one water (Lake Carey) was removed from the stocking program due to the loss of public access, and one water (Lake Galena) was removed due to poor survival of stocked Walleyes. The remaining Stable waters continue to be stocked with Walleye fingerlings.

Table 13. Walleye stocked waters evaluated since 2011 that resulted in management action.

Water	Resource category	Class	Management action
Belmont Lake	Medium Reservoir	Last Chance	Discontinue stocking
Canoe Creek Lake	Medium Reservoir	Last Chance	Discontinue stocking
Conneaut Lake	Large Reservoir	Last Chance	Discontinue stocking
Crooked Creek Lake	Medium Reservoir	Last Chance	Discontinue stocking
Fairview Lake	Medium Reservoir	Last Chance	Discontinue stocking
Gordon Lake	Medium Reservoir	Last Chance	Continue stocking
Gouldsboro Lake	Medium Reservoir	Last Chance	Discontinue stocking
Hemlock Lake	Medium Reservoir	Last Chance	Discontinue stocking
Hills Creek Lake	Medium Reservoir	Last Chance	Discontinue stocking
Justus Lake	Medium Reservoir	Last Chance	Discontinue stocking
LeBoeuf Lake	Medium Reservoir	Last Chance	Discontinue stocking
Long Pond	Medium Reservoir	Last Chance	Discontinue stocking
Lower Woods Pond	Medium Reservoir	Last Chance	Drawn down; no stocking

Water	Resource category	Class	Management action
Mahoning Creek Lake	Medium Reservoir	Last Chance	Discontinue stocking
Mauch Chunk Lake	Medium Reservoir	Last Chance	Discontinue stocking
Piney Reservoir	Large Reservoir	Last Chance	Continue stocking
Prompton Lake	Medium Reservoir	Last Chance	Discontinue stocking
Shawnee Lake	Medium Reservoir	Last Chance	Continue stocking
Tamarack Lake	Large Reservoir	Last Chance	Refilled – stocking resumed in 2021
White Oak Pond	Medium Reservoir	Last Chance	Discontinue stocking
Yellow Creek Lake	Large Reservoir	Last Chance	Continue stocking
Beechwood Lake	Medium Reservoir	Priority	Discontinue stocking
Cross Creek Lake	Medium Reservoir	Priority	Discontinue stocking
Curwensville Reservoir	Large Reservoir	Priority	No stocking; natural reproduction
Falls Township Park Lake	Medium Reservoir	Priority	Continue stocking
High Point Lake	Medium Reservoir	Priority	Discontinue stocking
Hinckston Run Reservoir	Medium Reservoir	Priority	Discontinue stocking
Kahle Lake	Medium Reservoir	Priority	Discontinue stocking
Kyle Lake	Medium Reservoir	Priority	Refilled – discontinue stocking
Lake Redman	Medium Reservoir	Priority	Discontinue stocking
Meadow Grounds Lake*	Medium Reservoir	Priority	Refilled – stocking to resume in 2022
Nockamixon Lake	Large Reservoir	Priority	Discontinue stocking
Pinchot Lake	Medium Reservoir	Priority	Discontinue stocking
Walker Lake	Medium Reservoir	Priority	Discontinue stocking
Lake Carey	Medium Reservoir	Stable	No stocking – loss of public access
Lake Galena	Medium Reservoir	Stable	Discontinue stocking
Lake Somerset	Medium Reservoir	Stable	Stocking to resume in 2022

- **Strategy 4. Several reservoirs and river sections were added to the Walleye stocking program during or after the completion of the 2011 Walleye Plan. These waters will be evaluated for continuance in the stocking program by 2022.**

  Progress: Waters new to the Walleye stocking program have been stocked for enough years to facilitate evaluation of the efficacy of stocking to establish a fishery and compare assessment catch rates to program criteria required for continuance in the stocking program. Waters listed in Table 14 are targeted for evaluation by 2022 and must meet catch rate guidelines outlined in the 2011 Walleye Plan for continuance of Walleye stocking.

Table 14. Waters targeted for evaluation by 2022.

Water	AFM	Resource category
Bridgeport Reservoir	8	Medium Reservoir
Cowanesque Lake	4	Large Reservoir
Hammond Lake*	4	Large Reservoir
Howard Eaton Reservoir	2	Medium Reservoir
Leaser Lake	6	Medium Reservoir
Long Arm Dam**	7	Medium Reservoir
Quemahoning Reservoir**	8	Large Reservoir
Sinnemahoning Creek, Section 01	3	Small River
West Branch Susquehanna River, Section 04	3	Small River
West Branch Susquehanna River, Section 05	3	Small River
West Branch Susquehanna River, Section 07	3	Major River
West Branch Susquehanna River, Section 08	3	Major River
West Branch Susquehanna River, Section 09	3	Major River

*Sampling resulted in change in management that extended target date for completion of evaluation.
**Evaluation complete.

At the time of this update, the number of rivers, lakes, and reservoirs managed for Walleyes with stocking has been reduced from 66 at the time of the 2011 Walleye Plan to 45. Forty-one waters are stocked with Walleye fingerlings only (including waters to be restored to stocking program in 2022), one water (Pymatuning Reservoir) is managed with both fry and fingerling stocking and three waters are managed for Walleyes with fry stocking only.

- **Strategy 5. Prioritize waters remaining in the Walleye stocking program for evaluation (other than those waters detailed above in Strategies 3 and 4).**

  Progress: Based on the results of Walleye population evaluations and lake refills, the number of waters (river sections, lakes, and reservoirs) managed for Walleyes through stocking PH1 fingerlings was reduced from 66 in 2011 to 42 at the time of this update. The waters currently managed for Walleyes through stocking have met program criteria to remain in the Walleye stocking program and are considered by AFMs to be desirable fisheries. These waters will be regularly evaluated to ensure stocking continues to provide quality Walleye fisheries. However, intermittent stocking between 2015 and 2017 has likely resulted in reduced abundance of adult Walleyes in affected waters and may result in survey catch rates below target levels. Multiple successive missing year classes may also become noticeable to anglers. Relative abundance surveys that occur during this period should consider the potential for multiple missing year classes when analyzing catch rate data relative to the catch rate guidelines established in the 2011 Walleye Plan.

- **Objective 4. Use hatchery-reared Walleye fingerlings in the most effective and efficient manner.**

  During the production years of 2015 through 2017, DFM requests for Walleye fingerlings exceeded the number produced in our hatchery system. In response, in 2018, the DFM adopted an alternate year stocking strategy, reducing fingerling request to approximately 750,000 per year. Concurrently, average annual production of Walleye fingerlings returned to historic levels (approximately 1.2 million) in 2018 and continued to increase in subsequent years, making the alternate year stocking strategy unnecessary. The alternate year stocking strategy was not utilized for the 2022 stocking requests; however, there is need for a mechanism to deal with production overages and shortfalls.

  - **Strategy 1. Use the supplemental stocking option to allocate excess production and the statewide priority system to account for production shortfalls.**

    Progress: During years when DFM requests for Walleye fingerlings exceed production, the statewide priority list will ensure the highest priority waters in the state receive Walleye fingerlings. AFMs will adjust their area priority assignments in subsequent years to account for waters that were not stocked with fingerlings.

    The DFM has reinstituted supplemental stocking options to allocate hatchery production that exceeds the base number of fingerlings requested. With the exception of studies to evaluate the efficacy of higher stocking rates (see Strategy 4 below), AFMs will prioritize all their waters for the base stocking rate of 20 per acre. Each AFM will then request a supplemental level 1 (S1) stocking for all desired waters at a rate of 30 per acre. If a water receives both its base and supplemental stockings, it will match the experimental 50 per acre stocking rate for the water selected in Strategy 4 below.

  - **Strategy 2. Continue to reduce the number of waters stocked with PH1 Walleye fingerlings to focus management on those waters capable of producing high-quality Walleye fisheries.**

    Progress: Results of previous surveys have reduced statewide the number of lakes and river sections stocked with PH1 Walleye fingerlings to 42. Additional evaluations may result in more waters being removed from the stocking program if minimum criteria for continuance are not met. However, should fingerling requests routinely exceed hatchery production capabilities, more waters will be removed from the program to focus Walleye stocking on those waters capable of supporting high-quality Walleye fisheries. This will require removal of waters that have met program criteria for continuance in the stocking program. AFMs will also consider estimated angler effort, assessment catch rates, and the proximity of other Walleye fisheries to inform management decisions.

  - **Strategy 3. Increase the average annual production of Walleye fingerlings at PFBC hatcheries.**

    Progress: To maintain or improve upon the current quality and quantity of Pennsylvania's Walleye fisheries, the BOH has been working to increase the number of fingerlings produced annually and recently these efforts have been met with success.

Despite shortfalls experienced from 2015 through 2017, production of Walleye fingerlings exceeded 2 million in 2013 and 2014, and production has exceeded 1.25 million PH1 Walleyes since 2018. Despite these advances, more Walleye fingerlings are needed to investigate the optimal stocking rate for PH1 fingerlings in individual waters as outlined in Strategy 4 below.

- **Strategy 4. Investigate the most cost-effective stocking rates to optimize return to anglers.**

Across North America, most Walleye fingerling are stocked at rates between 75 and 125 per hectare (31 to 52 per acre) with a range of 11 to 864 per hectare (4.5 to 350 per acre) (Kerr 2011). The Ohio Division of Wildlife stocks Walleye fingerlings at a minimum rate of 40.5 per hectare (100 per acre) (Curt Wagner, Ohio Division of Wildlife, personal communication). Kerr (2011) detailed several studies that determined little relationship between the stocking rate of Walleye fingerlings and the number of Walleyes recruited to the fishery. Similarly, Reed and Staples (2017) came to the same conclusion when comparing stocking rates of 30 and 60 Walleye fingerlings per littoral acre in 19 Minnesota lakes.

The 1988 Walleye Plan called for low and high stocking rates for Walleye fingerlings in Pennsylvania defined as 20 per acre and 40 per acre, respectively. These rates remained in effect up to and through the 2011 Walleye Plan. However, when stocking requests exceeded production from 2015 through 2017, a maximum stocking rate of 20 per acre was established beginning in 2018.

Historically, relative abundance data collected by the DFM suggested that some waters may require a stocking rate higher than 20 fingerlings per acre to create quality Walleye fisheries. The effect of different stocking rates on the relative abundance of YOY and adult Walleyes has not been rigorously evaluated in Pennsylvania.

Fisheries Management Area 8 determined a stocking rate of 100 PH1 Walleyes per acre created a high-quality Walleye fishery in Green Lick Reservoir. The reservoir was not stocked in 2016 and 2017 due to production shortfalls and the reduction of the annual stocking rate to 20 per acre in 2018 caused a substantial decline in adult Walleyes and assessment catch rates fell below the 2011 Walleye Plan guidelines to remain in the stocking program. Nighttime boat electrofishing CPUE fell from 58 Walleyes per hour in 2016 to 13 Walleyes per hour in 2019.

Progress: The return to historic levels of Walleye fingerling production allows the DFM to begin experimenting with higher stocking rates on select waters. Beginning in 2022, each AFM will select one water to stock fingerlings at a rate of 50 per acre for at least 5 years. The AFM will sample the selected water for Walleye YOY in at least 2 of the 5 years, although annual sampling is preferred. Following the fifth year of stocking, the AFM will survey the selected water for adult Walleyes using early spring nighttime boat electrofishing, Pennsylvania style trap nets, and/or gillnets per guidelines outlined in the 2011 Walleye Plan.

Other studies to evaluate varied stocking rates of Walleye fingerlings are being considered.

- **Objective 5. Investigate new techniques to determine contribution of stocked Walleyes to fisheries.**

  - **Strategy 1. Determine the efficacy of laser ablation otolith microchemistry as a technique to determine the origin of Walleyes captured during field sampling.**

    Progress: Otolith microchemistry analysis may be a reliable technique to identify hatchery contributions to Walleye populations. The chemical composition of otoliths is influenced by water where fishes reside during different life stages. As such, determination of a unique chemical signature produced by trace elements in otoliths compared to that of water sources can potentially provide insight regarding the origin of Walleyes and inform stocking decisions. This technique has been used to discern Walleyes stocked as fry from Walleyes produced by natural reproduction through analysis of otolith microchemistry.

    The PFBC has contracted with Southwest Missouri State University to perform laser ablation otolith microchemistry analysis on a sample of otoliths from YOY Walleyes collected in 2018 from the Allegheny River along with 60 reference Walleye fry left over from OTC tag verification. This is a pilot study to determine efficacy of this technique to evaluate Walleye stocking practices and will be performed in conjunction with OTC tag analysis to compare the efficacy of each method and their associated costs.

    For each YOY collected, one otolith was sent to the FPS lab at Benner Spring SFH for OTC tag analysis. The second otolith was sent to the contractor for microchemistry analysis. None of the YOYs collected from the Allegheny River exhibited an OTC tag, meaning all were the result of natural reproduction. Results of the microchemistry analysis on the second otoliths have been delayed due to equipment malfunctions and other logistical issues. Upon receipt of these results we can determine the future utility of this technique.

    OTC tags will continue to be used to verify hatchery origin for Walleyes stocked as PH1 fingerlings because it has proven effective in that regard. Should otolith microchemistry analysis prove reliable and cost efficient, it could eliminate the need to OTC tag hatchery Walleyes for stocking evaluations.

  - **Strategy 2. Perform genetic analysis of our existing Walleye fisheries and brood stocks.**

    Previous studies have examined the genetics of some of Pennsylvania's Walleye populations such as those in the Great Lakes (McParland et al. 1999, Brenden et al. 2015) and the Ohio River basin (White et al. 2005; Zipfel and White 2006), among others. However, little emphasis has been devoted to analysis of the genetics of the naturalized Walleye populations in the Susquehanna River and Delaware River basins. Such analysis would inform Walleye management in those watersheds.

    One application of genetic analysis is genetic-based tagging, which has been applied in many studies over the past 30 or more years (Murphy et al. 1983; McParland et al. 1999;

Henry et al. 2008; Haxton et al 2015; Brenden et al. 2015). Genetic- or parentage-based tagging, is a technique that compares the genetic makeup of wild caught Walleyes to hatchery brood sources to determine whether wild populations are attributable to natural reproduction or stocking programs. In contrast to analysis of otoliths, the use of genetics to measure hatchery contributions to Walleye populations does not require fish to be sacrificed for analysis.

Genetic analysis could also be used to determine the original source(s) for the naturalized Walleye populations in the Susquehanna and Delaware River watersheds, evaluate the contribution to fisheries from different brood stocks, and provide insight regarding potential risks of stocking Walleyes obtained from other states. However, the primary drawback to genetic analysis is the high cost relative to other previously described techniques. The PFBC does not have the capability to perform genetic analysis and testing would have to be performed by an outside entity contracted by the PFBC. As such, the use of this technique is currently a low priority project, but one that should be considered if needed.

- **Objective 6. Information regarding angler demand, use, and satisfaction with Pennsylvania's Walleye fisheries is needed to inform management decisions and provide enhanced Walleye angling opportunities.**

  - **Strategy 1. Conduct a human dimension survey to estimate and assess the following parameters:**
    - **proportion of Pennsylvania anglers that fish for Walleyes;**
    - **angler demand for Walleye fishing opportunities;**
    - **angler preference for a destination waters management strategy versus the current management strategy;**
    - **angler satisfaction with current management practices and the state of Walleye fishing;**
    - **angler definitions of high-quality Walleye fisheries;**
    - **angler acceptance of potential new regulations; and**
    - **angler acceptance of a voluntary Walleye permit.**

  During 2016, the PFBC conducted a black bass human dimension survey to assess angler preferences and opinions regarding black bass fishing; assess bass angler satisfaction with existing black bass regulations and alternatives; characterize black bass angler annual catch, harvest, trips, and destinations; characterize perception of a quality black bass fishing trip in Pennsylvania; and better understand black bass anglers and their views on bass tournaments and bass fishing guide services (Lorantas et al. in review). Similar information is needed to inform Walleye management in Pennsylvania.

  The 2011 National Survey of Fishing, Hunting and Wildlife-Associated Recreation estimated that 7% of Pennsylvania anglers targeted Walleyes compared to 58% that targeted black bass (U.S. Department of Interior et al. 2014). This disparity in angler effort would require sending eight times as many mail surveys for the Walleye Angler Survey than was necessary for the black bass survey to acquire roughly the same number of responses. Therefore, the PFBC will utilize a different method to deploy the survey instrument. A timeline and a methodology are proposed below for constructing and delivering the Walleye Angler Survey, (Table 18).

Table 18. Proposed timeline to complete the Walleye Angler Survey.

Task	Duration	Start date	Finish date
Develop Walleye Angler Survey questionnaire	6 months	1-1-22	6-30-21
Design survey in Qualtrics and test	1 month	7-1-22	7-31-22
Deploy Walleye Angler Survey via email	1 month	8-1-22	9-6-22
Send reminders or enlarge sample pool via email (if necessary)		9-7-22	
Analyze results	3 months	10-1-22	12-31-22
Update Walleye Plan using data collected by the Walleye Angler Survey	6 months	1-1-23	6-30-23

- **Strategy 2. Use single-day angler interviews on Walleye stocked waters to gather angler opinions and identify waters that may require a more thorough angler use survey.**

  In 2017, the DFM instituted single-day angler use and opinion surveys on Medium Reservoirs stocked with Walleye fingerlings. The surveys occurred during a weekend day on or soon after the opening day of Walleye season, a period of traditionally high Walleye angler use. The goal of these surveys was to gather angler opinions regarding the closed season for Walleyes and to obtain a cursory assessment of angler use directed at Walleyes on selected waters.

  In 2017, surveys occurred on seven lakes and reservoirs stocked with Walleye fingerlings, and 167 angler interviews were conducted. Of the 167 anglers interviewed, 85 (51%) were either actively fishing for Walleyes or self-identified as Walleye anglers on a specific water. Of all 167 anglers interviewed, 56% responded positively to eliminating the closed season for Walleyes in stocked waters and allowing angling and harvest on a year-round basis (five anglers had no opinion). Of the 85 Walleye anglers, 46% responded positively to eliminating the closed season for Walleyes in stocked waters and allowing angling and harvest on a year-round basis (one angler had no opinion). On most waters, angler opinions regarding the current closed season were polarized with anglers either strongly agreeing or disagreeing with eliminating the closed season.

  In 2018, this survey was repeated on seven new waters. One water in Area 6 surveyed in 2017 was surveyed again in 2018. One water surveyed in 2018 was a Large Reservoir. Of the 136 anglers interviewed, 45 (33%) were actively fishing for Walleyes or self-identified as Walleye anglers. Of all anglers interviewed in 2018, 45 (33%) favored the elimination of the closed season and the no-harvest restriction for Walleyes in stocked waters during this period. Of the 45 Walleye anglers, 15 (33%) favored the elimination of the closed season and the no-harvest restriction (year-round fishing for Walleyes). Summarizing from both years, both the majority of all anglers and the majority of Walleye anglers preferred to maintain the current closed seasons on Walleyes.

Questions regarding opinions of a closed season for Walleyes will be included in the Walleye Angler Survey as described in Objective 6, Strategy 1. One day creel surveys may continue at an AFM's discretion.

These single day surveys revealed some Walleye stocked waters see substantial angler use directed at Walleyes; however, several waters had limited Walleye angler use. These single-day surveys provided cursory insight regarding Walleye angler interest at specific waters, but they do not provide adequate data to inform management decisions regarding continuance of specific waters in the Walleye stocking program. These data do, however, identify waters that require additional data regarding Walleye angler use. As such, a traditional creel survey may be necessary to inform Walleye management on these waters.

- **Strategy 3. Conduct traditional creel surveys on Large and Medium Reservoirs managed for Walleyes with stocking. Existing data regarding use, harvest and angler opinions are dated and new information is needed to inform Walleye management.**

  The 1988 Walleye Plan identified angler use and harvest benchmarks as measurements of successful management of Walleye fisheries in Pennsylvania. The 2011 Walleye Plan was developed due to a shift in management to stocking Walleyes to produce high-quality targeted Walleye fisheries rather than provide a diversity of Walleye angling opportunities throughout the state.

  Ultimately, the best measurement of successful Walleye management is high angler use and satisfaction with Walleye fishing on both an individual water and statewide basis. Traditional creel surveys conducted during the peak of the Walleye fishing season are the most effective means to assess angler use, catch, and harvest on individual waters. When combined with the appropriate questions, data regarding angler opinion and satisfaction may also be collected. Creel surveys are resource intensive but represent the best means to assess program performance; thus, implementation remains a priority. Walleye-specific creel surveys may target seasonal high catch rate periods to minimize cost and maximize efficiency.

- **Objective 7. Evaluate and revise Walleye angling regulations to optimize Walleye fisheries as needed.**

  - **Strategy 1. Remove the closed season to allow year-round harvest at lakes and reservoirs with Walleye fisheries maintained entirely through stocking.**

    Most reservoir Walleye fisheries are maintained through hatchery stocking of Walleye fingerlings. As such, a closed season designed to protect spawning Walleyes from harvest is not biologically necessary to maintain populations. Furthermore, a closed season limits recreational angling opportunities for Walleyes when they are most vulnerable to angling. Pymatuning Reservoir, arguably Pennsylvania's most prominent inland Walleye fishery, has been managed without a closed season for Walleyes for decades and receives high angler use when most other waters in Pennsylvania are closed to Walleye harvest.

Preliminary results of water-specific Walleye angler opinion surveys show limited support for the elimination of the closed season on Walleye fisheries maintained through fingerling stocking. During single-day surveys as described above in Objective 5, Strategy 2, the majority of anglers opposed the elimination of the closed season. However, some water-specific angler opinions were strongly in favor of removing the closed season regulation.

The overall limited support for the elimination of the closed season on stocked waters suggests that a programmatic change for all waters is not appropriate. As such, AFMs shall consider water-specific applicability of this potential regulation change which may require additional single-day surveys to gauge angler acceptance. A pilot program will be considered for waters with high angler acceptance of the stocked Walleye waters open to year-round fishing approach. Additionally, a reduced creel limit and increased size limit during the spawning period could be considered and make a new regulation more acceptable to unsupportive anglers. Information regarding angler acceptance of this potential regulation change will also be collected as part of the Walleye-specific human dimension survey.

- **Strategy 2. Evaluate the efficacy of current Walleye angling regulations to protect and maintain fisheries supported solely through natural reproduction.**

With Walleye fisheries in multiple major river sections sustained solely through natural reproduction, scrutiny of the effectiveness of the statewide minimum size limit of 15 inches (381 mm) to sufficiently protect spawning stocks, particularly females, may be needed. Harvest of immature females prior to their first spawn can result in overexploited fisheries (Maciena et al. 1998; Myers and Barrowman 1996). Sexual maturation rates are not fixed over time within a population or among different Walleye stocks and are affected by both biotic and abiotic factors (Wang et al. 2009). Estimates of sexual maturation rates, angler exploitation rates, and relationships between stock size and recruitment for Walleye populations residing in Pennsylvania rivers are needed to inform management.

Maturity is usually reported as the average total length at which 50% of the fish in a population is sexually mature (male and female Walleyes are calculated separately due to sexual dimorphism), and maturation rates for Walleyes have been measured throughout their geographic extent. Scott and Crossman (1973) generalized maturity for female Walleyes at 356 – 432 mm (14 – 17 in) and 3 – 6 years of age and for males at 279 mm (11 in) and 2 – 4 years of age.

In Pennsylvania, a study conducted in 1984 and 1985 estimated Walleye maturation rates in Pymatuning Reservoir from fish captured in fall gill nets (Hoopes et al. 1986; Hoopes and Lee, 1985). The mean length at which more than 50% of the female Walleyes were sexually mature was 443 mm (17.4 in) in 1984 and 432 mm (17.0 in) in 1985 (Tables 19 and 20).

Table 19. Maturation rates for female Walleyes in Pymatuning Reservoir in 1984.

Observed age	Spawning age	Sample size	Length range	Mean length (mm)	Number mature	Percent mature
I+	II	5	323-347	330	0	0
II+	III	10	381-416	397	1	10
III+	IV	34	374-496	443	26	76
IV+	V	11	483-562	520	10	91
V+	VI	4	551-588	564	4	100
VI+	VII	1	615	615	1	100
VII+	VIII	1	615	615	1	100
VIII+	IX	1	650	650	1	100

Table 20. Maturation rates for female Walleyes in Pymatuning Reservoir in 1985.

Observed age	Spawning age	Total N	Length range	Mean length (mm)	Number mature	Percent mature
I+	II	11	180-312	270	0	0
II+	III	13	370-427	402	4	30.7
III+	IV	9	415-455	432	9	100
IV+	V	24	432-510	472	24	100
V+	VI	1	551	551	1	100
VI+	VII	4	590-631	611	6	100
VII+	VIII	1	635	635	1	100
VIII+	IX	2	671-701	686	2	100

Preigel (1969) reported maturation rates for Walleyes in Lake Winnebago and compared them to values reported in other studies. In Lake Winnebago, females matured at 18.9 inches (480 mm) at Age 6 and males matured at 12.7 inches (323 mm) at Age 3. Other studies reported by Preigel (1969) included the following sizes at which Walleyes attained sexual maturity: females in Saginaw Bay matured at an average length of 17.0 inches (432 mm) and males at 15.5 inches (394 mm) (Hile 1954); females in Gogebic Lake in Michigan matured at 15.4 inches (391 mm) and males at 12.2 inches (310 mm) (Eschmeyer 1950); half of males in northern Green Bay of Lake Michigan were mature at 15.5 inches (394 mm) and half of females were mature in the 17-inch size group (432 – 455 mm) (Balch 1951). These estimates of maturation rate and other more recent estimates are presented in Table 21.

Table 21. Walleye maturation rates reported in peer reviewed literature.

Author/agency	Year	Water	Size at maturity*			
			Females (mm)	Inches	Males (mm)	Inches
Preigel	1960	Lake Winnebago	480	18.9	323	12.7
Hile	1954	Saginaw Bay	432	17.0	394	15.5
Eschmeyer	1950	Gogebic Lake	391	15.4	310	12.2
Balch	1951	Green Bay	432	17.0	394	15.5
Hoopes	1984	Pymatuning Lake	443	17.4	328	12.9
Hoopes	1985	Pymatuning Lake	432	17.0	340	13.4
Ohio DNR	1992 - 2006	Western Basin Lake Erie	459	18.1	329	13.0
Ontario MNR	1990 - 2006	Western Basin Lake Erie	419	16.5	395	15.6
Ohio DNR	1981 - 2006	Central Basin Lake Erie	465	18.3	332	13.1
Ontario MNR	1989 - 2006	Central Basin Lake Erie	449	17.7	328	12.9
Ontario MNR	1989 - 2006	Eastern Basin Lake Erie	434	17.1	436	17.2
New York DEC	1981 - 2006	Eastern Basin Lake Erie	464	18.3	377	14.8
Michigan DNR	1989 - 2006	Saginaw Bay	455	17.9	383	15.1
Cornell Univ.	1961 - 2005	Oneida Lake	383	15.1	327	12.9
Gangl and Pereira	1989 - 1998	Cass Lake	459	18.1	-	-
Gangl and Pereira	1989 - 1998	Lake Kabetogama	404	15.9	-	-
Gangl and Pereira	1989 - 1998	Lake of the Woods	458	18.0	-	-
Gangl and Pereira	1989 - 1998	Leech Lake	438	17.2	-	-
Gangl and Pereira	1989 - 1998	Mille Lacs	441	17.4	-	-
Gangl and Pereira	1989 - 1998	Rainy Lake	394	15.5	-	-
Gangl and Pereira	1985 - 1989	Upper Red Lake	407	16.0	-	-
Gangl and Pereira	1989 - 1998	Upper Red Lake	423	16.7	-	-
Gangl and Pereira	1989 - 1998	East Vermillion Lake	407	16.0	-	-
Gangl and Pereira	1989 - 1998	West Vermillion Lake	452	17.8	-	-
Gangl and Pereira	1989 - 1998	Winnibigoshish Lake	430	16.9	-	-
Gangl and Pereira	1998 - 2000	Mississippi River Pool 2	505	19.9	-	-

*Size at maturity reported as mean length at which 50 percent are mature.

The above studies suggest most female Walleyes become vulnerable to harvest before their first spawn under Pennsylvania's current minimum size limit of 381 mm (15 in.). This could potentially lead to over exploitation and population instability in Pennsylvania waters; however, we do not have estimates of sexual maturation rates or exploitation rates for Walleyes in these specific rivers.

Hoopes and Young (1988) proposed a "Brood Stock Protection" regulation for Walleyes that consisted of an 18-inch minimum size limit, two fish per day creel limit coupled with the current closed season. An increased size limit to 18 inches would provide additional protection to females in populations sustained through natural reproduction and would be consistent with the PFBC's Resource First philosophy.

To inform the need for an increased minimum length limit, estimates of sexual maturation rates, angler exploitation rates, and the relationships between stock size and recruitment for Walleye populations in Commonwealth waters sustained through natural reproduction is needed. Evaluation of sexual maturity rates has begun on some Pennsylvania rivers. Otherwise, relevant literature suggests that increasing the minimum length limit in Pennsylvania to 17 inches would protect a substantial number of immature female Walleyes from harvest. Angler acceptance of more conservative harvest regulations for Walleye fisheries sustained through natural reproduction will be solicited during the Walleye Angler Survey.

- **Objective 8. Refine Walleye stocking practices and rates to optimize return to anglers as needed.**

  - **Strategy 1. Investigate the most cost-effective stocking practices to improve survival rates of stocked Walleyes.**

    A wide range of biotic and abiotic factors affect recruitment of Walleyes (Hansen et al. 1998). Most studies investigated factors affecting recruitment in naturally reproducing populations.

    Factors that influence recruitment of stocked Walleyes include lake surface area, conductivity, percentage of muck bottom and maximum depth (Nate et al. 2001); predation by other species, particularly Largemouth Bass (Kerr 2011); and the density, species composition and size structure of the forage base (Kerr 2011).

    Many factors that affect recruitment are not easily manipulated. One biotic factor that significantly influences Walleye recruitment is predation of recently stocked Walleyes by the resident predators of the receiving water (Kerr 2011). Any strategy that reduces predation on stocked fingerlings is, in effect, an increase in the stocking rate. Furthermore, increased survival of stocked fingerlings will provide cost savings by reducing the number of Walleyes required to stock to meet management objectives.

    Two strategies may reduce predation on Walleye fingerlings at the time of stocking: 1) stock fingerlings in the limnetic zone (Reed and Staples 2017), and 2) stocking fingerlings at night (Cheever 2004). Given that these approaches are recommended and supported by the literature and current DFM workload precludes evaluation of these techniques on a statewide basis, their efficacy in Pennsylvania waters will evaluated

through a small-scale pilot project conducted on a select number of waters by Fisheries Management Areas 1 and 2. The evaluation of these techniques will take place on a limited number of waters annually. Selected study waters will be stocked with half of their annual allocation under normal procedures (daytime stocking at one access point). The second half will be OTC tagged and stocked either at night or in the limnetic zone, or a combination of both techniques. Areas 1 and 2 will assist hatchery staff with fingerling stocking as needed and will evaluate the relative contribution of each stocking technique using fall nighttime boat electrofishing.

Progress: Fisheries Management Areas 1 and 2 have evaluated limnetic zone stocking in four Medium Reservoirs in Fisheries Management Area 2, two in 2019 and two in 2020. Three of the waters failed to produce a year class, regardless of stocking location, and one water (Woodcock Creek Lake) had the majority of YOY Walleyes result from the traditional near shore stocking method. Evaluation of this stocking is complete and the evaluation of nighttime stocking will begin in 2022 or 2023.

- **Objective 9. Update catch rate benchmarks used to inform Walleye management.**

  - **Strategy 1. Evaluate the need to refine the minimum survey catch rates for inclusion in the Walleye stocking program set in the 2011 Walleye Plan.**

    Progress: Current benchmarks that define a desired Walleye population and are used as minimum criteria for inclusion in the Walleye stocking program are based almost solely upon CPUE data collected during surveys conducted by DFM staff.

    A thorough review by the Walleye workgroup of all Walleye stocking and all sampling data for the waters in the Walleye stocking program is needed to evaluate the efficacy of currents benchmarks to define high-quality Walleye fisheries and determine the need for alternative benchmarks for waters to remain in the program and consideration of inclusion of new waters.

  - **Strategy 2. Use data collected with the Walleye Angler Survey to determine which waters are considered to be quality Walleye fisheries by anglers and determine if any correlation exists between angler opinions pertaining to quality Walleye fishing and survey catch rates.**

    It is unknown whether the density of Walleyes in a population as indexed by a trap net survey catch rate of 0.15 per hour (minimum criteria for inclusion in the stocking program) meets angler expectations of a quality Walleye fishery.

    Anglers will be given the opportunity to provide their definition of a quality Walleye fishery in the Walleye Angler Survey. They will also be able to select which Pennsylvania waters meet their Walleye angling expectations. A comparison of angler expectations of a quality fishing experience with historic survey catch rates at waters targeted for Walleyes will identify any potential correlation that exists and inform the evaluation of the efficacy of benchmarks described in Strategy 1 above.

- **Objective 10. Reinstitution of stocking at refilled reservoirs and addition of new waters to the Walleye stocking program**

  Four waters recently drawn down or drained for dam repairs have been or are in the process of being refilled. By 2022, three of the four will be restored to the Walleye fingerling stocking program. When stocking is resumed for a recently refilled reservoir, the water will be eligible for stocking at a rate of 40 PH1 fingerlings per acre for five consecutive years before moving to the 20 per acre stocking rate. Evaluation of all stockings will be performed by procedures outlined in the 2011 Walleye Plan with fall nighttime boat electrofishing for YOY Walleyes and an early spring nighttime boat electrofishing and/or a trap netting survey four to six years after the initial stocking.

  Although most Medium and Large Reservoirs in Pennsylvania have been stocked with Walleyes in the past, there may be some opportunities to stock new waters. Similar to recently refilled reservoirs where Walleye stocking is re-instituted, new additions to the program will be eligible to be stocked at a rate of 40 PH1 fingerlings per acre for five consecutive years before going to the 20 per acre standard rate. A qualifying survey will then be completed to determine if the Walleye plants produced a quality fishery and meets minimum benchmarks for continuance in the stocking program as detailed in the 2011 Walleye Plan.

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