AGENDA

Board of Wildlife Resources
Wildlife and Boat Committee
7870 Villa Park Drive
Henrico, Virginia 23228

October 27, 2021
10:00 am

Committee Members: Ms. Karen Terwilliger, Chair, Mr. Leon Boyd, Dr. Mamie Parker, Mr. John Daniel, Alternate and Mr. Rovelle Brown, Alternate

DWR Staff Liaisons: Dr. Gray Anderson and Dr. Mike Bednarski

1. Call to Order and Welcome
   Ms. Karen Terwilliger

2. Approval of the August 18, 2021 Committee Meeting Minutes ***Final Action***
   Ms. Karen Terwilliger

3. Public Comment – Non Agenda Item
   Ms. Karen Terwilliger

4. Fisheries Regulation Cycle - 2022-2023
   Dr. Mike Bednarski

5. Fish Management Plans – Walleye, Muskellunge, Striped Bass, and Catfish ***Action***
   Dr. Mike Bednarski

6. RAWA Readiness Assessment ***Action***
   Ms. Becky Gwynn

7. Bear Mange Update
   Ms. Katie Martin

8. Outreach and Education on the HRBT Seabird Colony
   Ms. Meagan Thomas

9. Wildlife Division Update
   Dr. Gray Anderson

10. Fish Division Update
    Dr. Mike Bednarski

11. Director's Report
    Mr. Ryan Brown

12. Chair's Report
    Ms. Karen Terwilliger

13. Next Meeting Date: Wednesday, January 19, 2022
    Ms. Karen Terwilliger

11. Additional Business/Comments
    Ms. Karen Terwilliger

12. Adjournment
    Ms. Karen Terwilliger

Draft Meeting Minutes

Wildlife and Boat Committee
Board of Wildlife Resources
7870 Villa Park Drive – Board Room
Henrico, VA 23228

August 18, 2021
10:00 am

Present: Ms. Karen Terwilliger, **Chair**; Mr. Leon Boyd, Dr. Mamie Parker; Alternates; Mr. John Daniel, Mr. Rovelle Brown; **Board Members** in attendance: Mr. G. K. Washington, Mr. Tom Sadler/Virtual, **Executive Director**: Mr. Ryan J. Brown; **Director's Working Group:** Ms. Becky Gwynn, Mr. Darin Moore, Dr. Mike Bednarski, Dr. Gray Anderson, Mr. Tom Guess, Ms. Paige Pearson,

The Chair called the meeting to order at 10:00 am and noted for the record that a Quorum was present for today's meeting.

The Chair called on the Board secretary for a roll call vote of Board members present: Ms. Karen Terwilliger, Mr. Leon Boyd, Dr. Mamie Parker, Mr. Rovelle Brown, Mr. Tom Sadler/Virtual, Mr. G. K. Washington and Mr. John Daniel.

Approval of the May 17, 2021 Committee Meeting Minutes:

The Chair called for a motion to approve the May 17, 2021 Wildlife and Boat Committee meeting minutes. Mr. Boyd made a motion to approve the minutes of the May 17, 2021 Committee meeting. Dr. Parker seconded the motion.

The Board secretary called a roll call vote: Ayes: Terwilliger, Boyd, and Parker

Public Comment - Non Agenda Item: The Chair called for Public Comment – Non-Agenda Items.

- Eric Fagerholm spoke regarding –To thank DWR for their work on the environment and to say the Department was on the right path for all sportsmen.

Proposed CWD Regulations in response to the Montgomery County positive: The Chair called on Mr. Cale Godfrey for a presentation.

Mr. Godfrey presented the Final Action on the proposed CWD Regulations in response to the Montgomery County positive.

After comments and questions, the Chair thanked Mr. Godfrey for his presentation on Proposed CWD Regulations for Montgomery County positive.

The Chair called for a motion. Mr. Boyd made a motion, Madame Chair, I move that the Wildlife & Boat Committee recommend that the Board of Wildlife Resources adopt the amendments to the chronic wasting disease regulations for Disease Management Area 3 as presented by staff. It was seconded by Dr. Parker.

The Board secretary called the roll. Ayes, Terwilliger, Boyd, Parker

Public Comment summary on proposed predator hunting contest regulation: The Chair called on Mr. Cale Godfrey for a report of Public Comments on Proposed predator hunting contest regulation.

Mr. Godfrey presented the public comments on proposed predator hunting contest regulation.

The Chair asked for Public Comments from the Public and Committee members:

- Ms. Heidi Crosky spoke regarding the predator hunting contest

After discussions and comments, The Chair thanked Mr. Godfrey for his update.

Wildlife Division Update: The Chair called on Dr. Gray Anderson for an update.

Dr. Anderson reported:

- Migratory and Hunting Regulations Digest have arrived and being distributed
- WMA's staff are busy getting prepared for the fall season
- Dove Season opens September 4, 2021

Fish Division Update: The Chair called on Dr. Mike Bednarski for an update.

Dr. Bednarski reported:

- Governor's Fishing Challenge scheduled for October 2, 2021 at Kiptopeke State Park. Planning a bird related activity with DCR to highlight the wildlife there at that time of year.
- Mussel Rama is coming up, 30 species of mussel on the Clinch River in Scott and Russell Counties. Highlighted contributions of DWR efforts to mussel restoration from the AWCC – 600K mussel released.
- Presented the Fish Regulatory cycle – Aquatic Wildlife schedule for 2022-2023

Director's Report: The Chair called on Executive Director Ryan Brown for a report.

The Director reported:

- DWR participated in the Sportsman Show
- Kick off for Fall Hunting
- Green Top Expo on October 2, 2021
- Dove Season starts September 4, 2021
- Governor's fishing Challenge on October 2, 2021
- HRBT Update - another successful season
- CWD involving Deer and mange on Bear situation

Chair's Report: The Chair thanked everyone for attending the Wildlife and Boat Committee meeting. The employees at DWR are such stewards of Fish and Wildlife and the dedication from the staff is wonderful. Looking forward to the work of the Wildlife Viewing Plan.

The Chair asked if anyone had any further comments or questions, hearing none, she announced that the next meeting will be determined and adjourned the meeting at 11:00 am.

Respectfully submitted,

Frances Boswell
/s/

A Plan for Managing Walleye/Saugeye in Virginia's Reservoirs and Rivers 2022-2027

VDWR Walleye Committee

Introduction

Walleye

Walleye (*Sander vitreus*) are native to the Big Sandy, Tennessee, and New River drainages of Virginia, and naturalized populations are found in the Roanoke and Nottoway drainages. However, most walleye populations in the Commonwealth are maintained by stocking. These stockings provide notable populations in many impoundments, but in other waters similar stockings do not succeed. Overall, the success of walleye stockings in Virginia meets or exceeds the reported success rate (32 percent) for maintenance stockings utilizing fry and small fingerlings (Ellison and Franzin 1992; Laarman 1978).

For nearly sixty years, fry and small fingerlings were stocked with two goals in mind; 1) to diversify angling opportunities, and 2) to utilize walleyes as forage control agents (Steinkoenig 1997). However, more specific goals and objectives were needed to address the growing demands and dynamic interests of the angling public. Prior to 2000, little emphasis was placed on establishing walleye populations that provided successful angling. Consequently, less than two percent of Virginia anglers listed walleyes as their preferred species, and overall catch rates were extremely low (Steinkoenig 1997).

The decade of the 1990's ushered in a lot of changes for walleye management in Virginia. Angler demand for walleye fishing increased dramatically due to advances in angling gear and techniques and the proliferation of information available through various media (Ellison and Franzin 1997). An internal committee was formed to coordinate research and management activities. Research projects answered questions about angler exploitation and population densities, and documented the seasonal movements and habitat preferences of walleyes in Virginia. Another project identified a unique genetic stock of walleyes in the New River. It was apparent that more specific goals and objectives were needed to address the growing demands and dynamic interests of the angling public.

A prioritized stocking and monitoring plan was developed in 2000 (Hampton 2000). Stocking efforts focused on impoundments that had a demonstrated potential to support walleye populations. The list of walleye impoundments was categorized to identify management goals and objectives, and link those goals and objectives with the stocking strategies that offered the highest probability of success. Standardized stocking rates and monitoring protocols were adopted for each impoundment category. The plan was designed as a working document, with the expectation that it would be refined and improved.

The plan guided walleye stocking practices across the Commonwealth from 2000 to 2004. The walleye committee convened in 2005 for a statewide comparison of sampling data. Relative abundance, angler preference and angler catch rates increased at several impoundments during this period. Objective evaluation of all walleye stockings also revealed poor performance at some impoundments previously thought to be 'good' walleye fisheries. Stockings were discontinued at these impoundments. The resulting surplus of walleye fingerlings provided the opportunity to expand stocking in several rivers and increase stocking rates and frequencies at some impoundments. Monitoring protocols were also modified for efficiency and effectiveness.

Subsequent walleye committee meetings in 2006 and 2007 resulted in more management changes. A five year walleye exploitation study from 2008-2012 on several small and large impoundments along with the New River produced statewide angler exploitation rates and a manuscript (Owens et. al. 2014). This document integrates the changes from the last 20 years of walleye management into a new plan that will guide walleye management from 2020-2025.

Saugeye

In 2013-2015, and 2019 saugeye (a hybrid cross of female walleye x male sauger) were stocked into several walleye fisheries in place of walleye. In some locations saugeye performed well and are now established in these waters and are desired by fisheries managers because of the hybrid vigor demonstrated. In waters where saugeye are stocked they will be managed similar to walleye, treated as walleye in the regulatory process and included in the states walleye management plan. The following conditions will be met in order to stock and manage saugeye in Virginia waters. Saugeye will not be stocked into drainages or waters that have naturally reproducing walleye populations and/or waters that provide walleye brood stock for hatchery production. This will reduce the risk of back crosses occurring in systems that have natural reproduction and prevent unwanted crosses of saugeye and walleye made at hatcheries if saugeyes are mistaken for walleye during brood stock collections. Goals and objectives, stocking rates, evaluation and priority levels for managing saugeyes will be the same as defined for walleye below.

GOALS AND OBJECTIVES

Walleyes are stocked to achieve a variety of management goals. The first step toward creating and maintaining an exceptional walleye fishery is to establish and maintain an abundant population. Higher relative abundance and increased numbers of quality fish provide better catch rates and increased species preference among anglers (Priority Waters). These priority waters can be further separated by management category; research, conservation and brood source, priority fishery and developing waters. Priority "research waters" are currently being studied for a defined time period to enhance and improve walleye management in Virginia while providing excellent walleye fishing opportunities. Priority "conservation & brood source waters" are managed to protect and enhance unique genetic stocks (New River) or to provide brood fish sources for hatchery

production for stocking throughout the state, while providing quality walleye fishing opportunities. Priority "fishing waters" are managed to provide excellent walleye fishing opportunities. Priority "developing waters" are managed to develop additional walleye fishing opportunities. The management goal of simply offering anglers the opportunity to catch a walleye can be achieved across a broad geographical area by establishing populations with lower relative abundance (Diversity Waters). To meet the management goals and objectives for walleye statewide there must be consistent production of walleye fingerlings from hatcheries (Consistent Production).

GOALS:

1) Priority Waters (research, conservation and brood source, priority fishery & developing) - To establish and maintain exceptional walleye populations that encourage angler utilization and appreciation of walleye fisheries and meet management objectives.
2) Diversity Waters - To establish fishable walleye populations that diversify angling opportunities.
3) Consistent Production – To consistently produce walleye fingerlings for annual allocations.

OBJECTIVES:

1) Priority Waters – (research, conservation & brood source, priority fishery, developing) maintain walleye populations that yield a CPE (catch per effort) $\geq$ 10 adults per hour of electrofishing or net night combined and maintain high angler utilization and preference for walleyes. Conservation waters also increase the frequency of target alleles in the walleye population.
2) Diversity Waters - maintain walleye populations that yield a CPE of at least 3 per hour or net night combined, if possible.
3) Consistent Production – to develop and improve hatchery production of walleye fingerlings to fill annual allocations.

MANAGEMENT CATEGORIES

The management emphasis for a particular impoundment or river determines which goals and objectives apply. Several management categories are needed to address the varied interests of a diverse group of anglers. **Priority waters** – (research, conservation & brood source, priority fishery, developing) offer walleyes as a featured species. Walleye populations in priority waters should have high relative abundance and good size structure, as well as documented angler utilization. **Diversity waters** simply provide the opportunity for anglers to catch walleye. This can be accomplished with lower population densities and at many locations across the commonwealth. The following table identifies the 17 waters in Virginia currently managed under this plan by water type and management category.

Waterbody	Type	Management Category
Shenandoah River	Priority Water	Research
Rivanna River	Priority Water	Research
New River	Priority Water	Conservation/Brood
Leesville (Staunton River)	Priority Water	Conservation/Brood
South Holston Reservoir	Priority Water	Conservation/Brood
Lake Chesdin	Priority Water	Priority Fishery
Flannagan Reservoir	Priority Water	Priority Fishery
Hungry Mother	Priority Water	Priority Fishery
Philpott Reservoir	Priority Water	Priority Fishery
Burke Lake	Priority Water	Priority Fishery
Orange Lake	Priority Water	Priority Fishery
Lake Whitehurst	Priority Water	Priority Fishery
Lake Brittle	Priority Water	Priority Fishery
North Fork Pound Lake	Priority Water	Developing Water
Lake Gaston	Diversity Water	Diversity Water
Lake Anna	Diversity Water	Diversity Water
Little Creek Reservoir	Diversity Water	Diversity Water

Stocking

Some of the factors that influence stocking success are source of fish, size at stocking, stocking rate, stocking frequency, and release methods. This plan includes specific stocking strategies tailored to the management goals of each impoundment category. Adopting standardized stocking protocols reduces the number of unknown factors that may influence survival, and allows for comparative evaluation.

SIZE:

1. Small fingerlings (25 to 50 mm TL)
2. Fry

Both sizes are currently available through hatchery production. Fry are cheaper to produce, but must be stocked at higher rates. Small fingerlings can be stocked later, and offer better survival. This plan recommends no change in the size of walleyes stocked. Small fingerlings should remain as the mainstay of the walleyes stocking program.

RATES:

Fingerling walleyes should be stocked at rates of 25, 50 or 100 per acre depending on the size and management category of the impoundment. Fingerling walleyes should be stocked at rates of 500, 1000 or 2000 per river mile depending on the management category of the river. Fry should be stocked at much higher rates to compensate for increased mortality. Fry are typically available as surplus.

FREQUENCY:

Priority waters (research, conservation & brood source, priority fishery, developing) **should be stocked each year to maintain consistent annual recruitment**. The order in which priority waters are stocked will be determined by the walleye committee and updated annually. Diversity waters should be stocked annually, but a staggered stocking schedule (stock two years, skip one year) would minimize the potential for consecutive missing year classes.

RELEASE METHODS:

In general walleye fingerlings should be stocked where foraging opportunity is maximized, predation potential is minimized, and future homing might create enhanced fishing opportunities. It is recommended not to overstock release sites to maintain high survival of stocked walleye (Sutton et al. 2013, Wilson 2004). In most systems this means stocking in the upper portion of the impoundment, where primary production is higher and spring runs bring spawning fish into narrow tributaries. In systems lacking fishable tributaries, stocking near a riprap dam may enhance angling opportunities if spawning fish congregate during the early spring. Pelagic stocking can reduce predation potential by minimizing interaction between walleye fingerlings and littoral-based centrarchids.

Monitoring

An effective monitoring plan is essential to evaluate the success of a stocking plan. Without the ability to relate year class strength to stocking size, rate and frequency it is impossible to evaluate a stocking program beyond the subjective designation as “success” or “failure”. Assessing year class strength early offers punctual feedback on stocking success, and provides the opportunity to predict future population levels.

Because Virginia walleye waters are diverse in size, fertility, and location, a single sampling protocol is not practical. Small impoundments and rivers are typically sampled using boat electrofishing gear, whereas a combination of electrofishing and gill netting is used for larger impoundments. Consistent sampling allows trend analyses and meaningful comparisons can be made among similar resources.

YOY and yearlings

Young-of-the-year walleyes can be collected the first fall after stocking. The most widely used method for collecting fall YOY walleyes in other parts of the United States is nighttime electrofishing. Sampling is effective as soon as water temperatures drop below 20° C. This method will work in Virginia, but the results vary widely among impoundments. YOY walleyes are routinely collected during nighttime electrofishing surveys at Hungry Mother Lake and South Holston Reservoir. Gradually sloping shorelines relatively close to the stocking location yield the highest catch rates. However, nighttime electrofishing for young walleyes is not very effective in some Virginia impoundments. Small mesh gillnets are another option for YOY walleyes. YOY walleyes are typically sampled in 0.75 and 1.0 inch bar mesh.

Yearling walleyes can be collected during spring and early summer by electrofishing. Daytime sampling can be successful, but nighttime samples generally yield more fish. Small mesh gillnets are another option for yearling walleyes. Yearling walleyes are susceptible to 1.25 and 1.5 inch bar mesh.

Young-of-the-year walleye sampling with electrofishing and gill nets may not be applicable in some systems due to very low catch rates. Philpott Reservoir has a very good walleye population but YOY walleye sampling has not been productive. However, walleye are collected in high numbers after age-1 and year class strength can be determined from sampling adults.

Adults

Adult walleyes generally are fully recruited to gillnet sampling at age two. They fully recruit to spring electrofishing at about the same age. These samples are particularly important because they give information about the fishable population. From these samples we will obtain an adult index of relative abundance, population estimates, age-and-growth data and size structure indices.

Electrofishing is an effective method for collecting walleyes when they occupy relatively shallow water. Daytime electrofishing is effective in some systems, but nighttime samples generally yield more fish per hour.

Angler Utilization

Angler utilization is the ultimate measure of success for the stocking program. Without utilization stockings create a population, not a fishery. Routine angler surveys provide a measure of angler utilization through catch rate or species preference data. Peak-season surveys that coincide with periods of concentrated fishing effort are ideal, because they maximize the number of interviews and decrease costs.

Angler exploitation studies (tagging studies) also measure utilization. These studies are particularly useful when traditional angler survey methods are difficult or impractical. For example, exploitation studies are beneficial if night fishing is the favorite method of local anglers. Exploitation studies are also a great way to determine patterns of catch and harvest that can be used to plan future peak-season surveys.

Evaluation

The walleye committee will meet regularly to evaluate the success or failure of walleye stockings. Each impoundment or river will be evaluated to determine if sampling results compare to stated objectives. Priority waters (research, conservation & brood source, priority fishery, developing) will maintain walleye populations that yield a CPE (catch per effort) $\geq$ 10 adults per hour of electrofishing or net night combined and maintain high angler utilization and preference for walleyes. Conservation waters will also aim to increase the frequency of target alleles in the walleye population. Diversity waters will maintain walleye populations that yield a CPE of at least 3 per hour or net night combined, if possible. If sampling results do not correspond with the objectives of the designated management category, the committee may assign a different management category or remove the impoundment or river from the list of stocked waters.

The committee will consider factors that influence stocking success and sampling results. For example, high exploitation rates can impede progress toward goals and objectives by reducing overall abundance or selectively removing older age classes (trophy fish). Reducing creel limits or establishing size restrictions may be necessary to achieve the stated goals and objectives. Since the year 2000, the statewide daily creel limit for walleye in Virginia has been reduced from eight fish to five fish, and a minimum length limit of 18 inches has been established statewide.

Walleye/Saugeye & R3

Recruitment, Retention and Reactivation (R3): Walleye Angling is an Opportunity to expand our Agency's R3 Efforts

Managing Virginia's Walleye populations requires considering time, costs, constituents, and potential fisheries benefits. One potential spinoff benefit of well-managed walleye fisheries is making select fisheries an R3 tool. Successful walleye angling typically requires advanced fishing skills. Walleye are challenging to catch, so using walleye as a recruitment method for beginning anglers may not be effective. However, good walleye fisheries are a great tool to recruit nonresident anglers to Virginia from neighboring areas because walleye populations are not abundant in southern states. Additionally, new residents relocating to Virginia from northern states where walleye fishing is common, are easily recruited into Virginia angling because of the high quality walleye angling opportunities. Moreover, walleye fishing can be used to retain and reactivate anglers as well. Since successful walleye angling requires the development of skills, the key is maintain and sustain high quality fisheries (numbers or size) in a variety of reservoirs and rivers to retain current walleye anglers. Stocking saugeye fingerlings into various impoundments establishes additional fishing opportunities along with increased angler catch rates of this highly aggressive hybrid of the walleye and sauger cross. Success with saugeye fishing opportunities could allow anglers to transition their attention and angling effort to pure strain walleye populations. Providing high quality and trophy walleye fisheries could allow for effective marketing of walleye as a tasty fish that offers a

challenge. Lapsed anglers can be targeted with a challenging fishery as a source of fresh tasting fish for meals to another tasty food source.

Literature Cited

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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.

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Wilson, D. M. 2004. Effects of expanded stocking locations on striped bass survival. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies 56(2002):79-85.

Priority Waters

(Research, Conservation & Brood source, Priority Fishery, Developing)

Definition: Walleyes are a featured species

Goal:

To establish and maintain exceptional walleye populations that encourage angler utilization and appreciation of walleye fisheries. Additionally, these priority waters may be used for research and study, brood source supply, genetically unique stocks conservation or developing new walleye fisheries.

Objectives:

1. Maintain walleye populations that yield 10 or more adult walleyes per net night or per hour of electrofishing combined.
2. Increase exploitation, catch rates and species preference percentages for walleyes

Stocking Strategy:

Size:	small fingerlings
Rate:	(50 per acre or 100 per acre), or (2,000 to 2,500 per river mile)
Frequency:	annually

Sampling Strategy:

Young-of-year	fall night electrofishing fall small mesh gillnets (0.75, 1.0 in. bar) in waters >500 acres fall small mesh gillnets in waters <500 acres if electrofishing fails
Adult	spring (March-April) night electrofishing in waters < 500 acres fall gillnets in waters >500 acres (1.25,1.5,2.0,2.5,3.0 in. bar mesh) collect walleyes during spring bass sample in all featured waters
Angler Utilization	angler survey to determine catch rates and species preference tagging to determine angler exploitation rates

Diversity Waters

Definition: Walleyes are stocked to diversify angling opportunities

Goal:

1. To establish walleye populations that offer angling opportunities

Objective:

1. Maintain walleye populations that yield 3 or more adult walleyes per net night or per hour of electrofishing combined.

Stocking Strategy:

Size:	small fingerlings
Rate:	25/acre in waters >1,000 acres 50/acre in most waters < 1,000 acres 100 per acre in waters < 30 acres
Frequency:	annually

Sampling Strategy:

Young-of-year	not required, however sampling detailed under featured waters is recommended if time allows
Adult	spring (March-April) night electrofishing in waters < 500 acres fall gillnets in waters >500 acres (1.25,1.5,2.0,2.5,3.0 in. bar mesh) collect walleyes during spring bass sample in all stocked waters
Angler Utilization	encouraged but not required

Appendix

Upper New River
Walleye Management Plan
2022 to 2027

Prepared by:

John R. Copeland, Fisheries Biologist

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Introduction:

Historically, Claytor Lake was stocked with fingerling Walleye from a variety of sources in the Midwestern United States, with no consideration of the genetic impact of those stockings. During the late 1970's, Brian Murphy provided evidence for a unique Walleye stock in Claytor Lake using enzyme based genetic analysis (Murphy et al 1983). A research investigation into the population genetic structure of Walleye in the Upper New River (upstream from Claytor Lake) from 1997 to 1999 determined that a unique Walleye stock inhabits this section of the New River (Palmer 1999, Palmer et al 2006, 2007). Documenting this unique Walleye stock resulted in a change in Walleye management on the 74 miles of river upstream from Claytor Lake, from Allisonia (Pulaski County - river mile 106) to Fields Dam (Grayson County – river mile 180), with supplemental fingerling stocking exclusively using New River Walleye genetic strain since 2000 by employing genetic marker assisted brood stock selection.

From 2000 to 2002, the trial and error process of the brood stock selection technique resulted in 10,000 New River strain Walleye being stocked in spring 2001. Greater success in brood fish collection and identification resulted in over 1.5 million New River strain Walleye being stocked from 2003 to 2021 (Table 1). Since a small local Upper New River Walleye fishery existed prior to annual stocking due to natural reproduction, no Walleye were stocked in 2012 and 2013 to evaluate the need for continued stocking. Virginia Department of Wildlife Resources fisheries biologists determined that annual fingerling stockings are required to maintain a viable recreational Walleye fishery based on (1) a Walleye population decline in 2014 and 2015 from this skip stocking (indicated by annual electrofishing surveys (Figure 1)); and, (2) collection of extremely limited numbers of naturally reproduced Walleye from 2012 and 2013 in subsequent population sampling. In addition, an Upper New River Walleye tagging exploitation study found that anglers catch approximately 26% of available Walleye annually, further reinforcing the need for annual fingerling stocking to maintain this fishery given Walleye angler propensity for harvesting their catch (Owens et al 2014).

Maintaining the quality of the Upper New River fishery is of particular interest because this river is the premier destination Walleye fishery in Virginia. The current (15 pounds, 15 ounces), previous, and historic (22 pounds, 8 ounces) state record Walleye were caught from the Upper New River. In addition, anglers catch numerous Walleye over 10 pounds from the river each year.

The Upper New River Walleye population is considered a Priority Water in the Virginia Department of Wildlife Resources Walleye Management plan with a Management category of Conservation/Brood. Maintaining a healthy and sustainable Upper New River Walleye population is a featured goal of the statewide Walleye management plan, emphasizing the Upper New River's importance as a Walleye brood stock source for Walleye stocking in multiple waters statewide.

Table 1: Approximate numbers and river area of fingerling stockings of New River strain Walleye from 2001 to 2021. Walleye stocking was not equally distributed throughout the river area stocked. Walleye were not stocked in 2012 and 2013 to evaluate natural reproduction.

Year	**No. Stocked**	**River Area Stocked (RM)**	**No. stocked per Mile**
2001	10,000	Allisonia to Buck Dam (106 to 128)	≈ 455
2003	51,840	Allisonia to Buck Dam (106 to 128)	≈ 2,356
2004	156,200	Allisonia to Fries Dam (106 to 138)	≈ 4,881
2005	90,080	Allisonia to Fries Dam (106 to 138)	≈ 2,815
2006	106,000	Allisonia to Fields Dam (106 to 180)	≈ 1,432
2007	20,000	Allisonia to Buck Dam (106 to 128)	≈ 909
2008	143,000	Allisonia to Fields Dam (106 to 180)	≈ 1,932
2009	67,140	Allisonia to Buck Dam (106 to 128)	≈ 3,051
2010	33,250	Allisonia to Buck Dam (106 to 128)	≈ 1,511
2011	143,000	Allisonia to Fields Dam (106 to 180)	≈ 1,932
2012	**None**		
2013	**None**		
2014	40,612	Allisonia Only (106)	Not applicable
2015	151,912	Allisonia to Fries Dam (106 to 138)	≈ 4,747
2016	26,354	Allisonia Only (106)	Not applicable
2017	150,100	Allisonia to Fries Dam (106 to 138)	≈ 4,691
2018	142,484	Allisonia to Fries Dam (106 to 138)	≈ 4,453
2019	105,000	Allisonia to Fries Dam (106 to 138)	≈ 3,281
2020	90,631	Allisonia to Fries Dam (106 to 138)	≈ 2,832
2021	109,478	Allisonia to Fries Dam (106 to 138)	≈ 3,421

Total: 1,637,081

Regulation Management

The Upper New River Walleye population was governed by a 508 mm minimum size limit with a 5 per day creel limit prior to January 1, 2011, when the regulation was changed to reduce harvest of female Walleye during the peak Walleye spawning season. From January 1, 2011 to December 31, 2020, the regulation was changed to the following: From Buck Dam downstream to Claytor Lake Dam: (1) From February 1 through May 31: All Walleye 483 mm to 711 mm caught must be released unharmed. Anglers may keep 2 Walleye per day less than 483 mm or over 711 mm; (2) From June 1 through January 31: A 508 mm minimum length limit with a five per day creel limit was in effect. On January 1, 2021, the slot limit was modified to require anglers to release all Walleye 483 mm to 711 mm (28 inches) year-round from Buck Dam downstream to Claytor Dam. The daily Walleye creel limit was held at 2 per day either less than 483 mm or over 711 mm.

Until January 1, 2021, from Buck Dam upstream to Fries Dam, the walleye population was governed by a 508 mm minimum size limit with a creel limit of 5 per day, with the intent of protecting the Walleye population in Byllesby Reservoir that runs upstream to Fries Dam. On January 1, 2021, the 508 mm minimum size limit was reduced to 457 mm and the creel limit was kept at 5 per day, in order to match the statewide Walleye size and creel limits.

Upstream from Fries Dam, where Walleye stocking has been limited to 3 years since 2001 and since Walleye are not established, the statewide regulation of 457 mm minimum size limit with a creel limit of 5 per day applies to any Walleye caught.

Current Fishery Status

Spring Electrofishing Sampling

Spring electrofishing is the primary tool used to evaluate the status of the Walleye population in the Upper New River. Results of spring electrofishing from 2000 through 2020 indicate that annual fingerling stocking directly affects the relative abundance of walleye in the Upper New River (Figure 1). The highest spring electrofishing catch rates of Walleye occurred from 2006 to 2013, following years with an average stocking rate of over 94,000 walleye fingerlings per year (2004 to 2011).

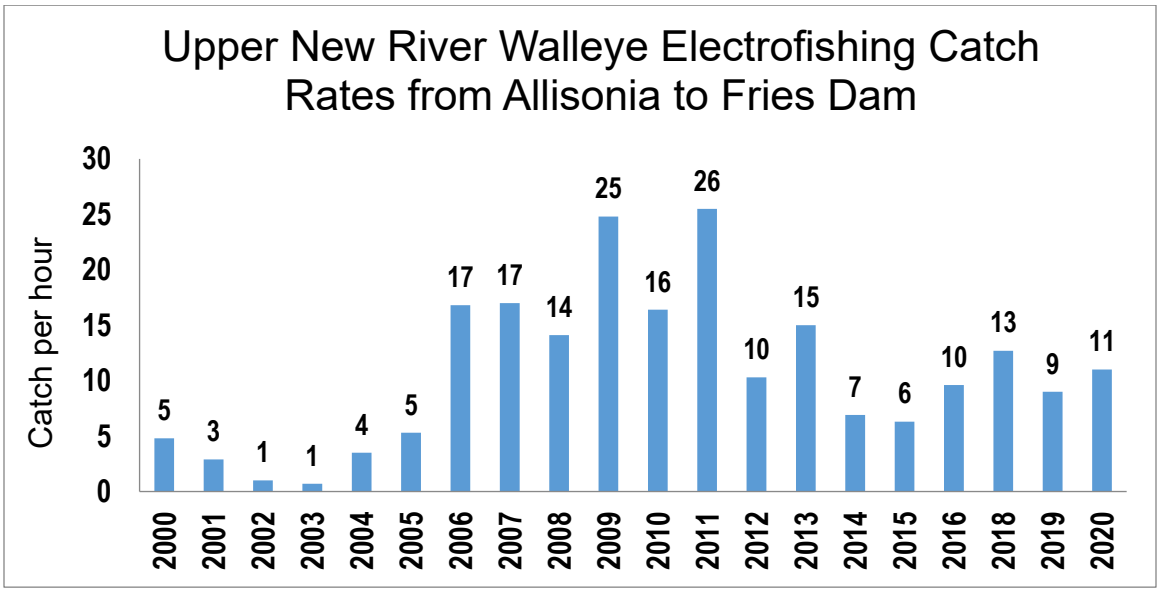

Figure 1: Upper New River walleye electrofishing catch per hour at multiple sites from Allisonia upstream to Fries Dam.

Angler Surveys

Angler surveys are a secondary tool used to evaluate the status of the Walleye population in the Upper New River. Peak season Walleye angler surveys (February to April) were conducted on the Upper New River from Allisonia to Buck Dam in 2007 and 2016. Angler effort varied between these surveys, with anglers expending 7,937 angler-hours in 2007 and 5,851 angler-hours in 2016, a 26% decline in effort. The decline in effort is most likely related to the reduced Walleye population in 2016 (indicated by walleye electrofishing catch rates in 2007 and 2016 in Figure 1). Walleye anglers fish primarily during the months of March and April (84% of 2007 angling effort and 100% of 2016 angling effort), accounting for the majority of the total fishing effort in those months during both survey years. Walleye fishing effort in February is variable. In 2007, February Walleye angling effort comprised 16% of the overall effort, while no walleye anglers were encountered in February 2016. March Walleye catch rates were consistent from 2007 to 2016 with anglers requiring 4 hours to catch a Walleye. April Walleye catch rates declined from 2007 to 2016, with anglers averaging 7 hours and 41 minutes to catch a Walleye in 2007 and 11 hours and

7 minutes in 2016. The overall Walleye catch rate for February to April 2007 of 0.34 per hour was twice the overall Walleye catch rate for February to April 2016 of 0.17 per hour, providing further evidence of a reduced Walleye population in the Upper New River. Harvest rates increased from 2007 to 2016, with 5% of the Walleye catch harvested in 2007 versus 27% of the Walleye catch harvested in 2016. In 2007, the 508 mm Walleye minimum size limit limited harvest of most of the Walleye caught, since most of the available Walleye were from the 2004 to 2006 year classes (Table 1), which were less than 508 mm at the time of that survey. In contrast, the 483 to 711 mm Walleye slot limit in 2016 likely promoted harvest of 356 to 432 mm Walleye in the population from stocking in 2014 and 2015.

Walleye Allele Frequencies

Upper New River Walleye allele frequencies are monitored primarily based on annual brood stock collections using genetic marker assisted brood stock selection. Between 2000 and 2017, allele frequencies at microsatellite loci *SVI-17* (99/99 allele) and *SVI-33* (78 allele) (the primary alleles identified by Palmer (1999)) increased from an average of 53% to an average of 77%, indicating success maintaining and improving the genetic integrity of the New River Walleye stock.

Management Goal, Objectives, and Strategies for 2022 to 2027

Goal: Maintain a genetically unique, naturally reproducing Upper New River Walleye stock that supports a quality recreational fishery over the 74 mile reach from Allisonia to Fields Dam.

Objectives:

1. To stabilize average spring electrofishing catch rates (CPUE) of adult Walleye (>250 mm) between 15 and 20 Walleye per hour.
2. To sustain angler catch rates of adult Walleye (>250 mm) of 1 fish per 4 hours of fishing during the peak Walleye fishing season from February through April.
3. To maintain or increase the allele frequency at microsatellite loci *SVI-17* (99/99 allele) and *SVI-33* (78 allele) of the New River stock Walleye.
4. To increase Walleye spawning stock to adequate levels for natural reproduction to support a viable recreational fishery.

Management Strategies:

a) Use genetic marker assisted brood stock selection of New River Walleye from known Upper New River spawning locations (typically Ivanhoe and Foster Falls) to produce fingerlings for annual stocking to maintain the Walleye population.
b) Evaluate the size and creel restriction on Walleye in the Claytor Dam to Buck Dam section of the Upper New River to assess if the regulation is having the desired effect in achieving the fishery objectives.
c) Negotiate reductions in peak power production at the Buck/Byllesby Hydroelectric Project during the peak Walleye spawning, hatching, and larval season (early March to early May) to reduce flow fluctuation impacts on Walleye spawning success and survival (Ney et al 1993; Mion, Stein, and Marschall 1998).

Monitoring Strategies:

a) Survey the population annually or semi-annually using microsatellite DNA markers at loci *SVI-17* and *SVI-33* and measure the allele frequency, using fin samples collected during annual brood stock collections and other sampling efforts on Claytor Lake and the Upper New River.

b) Conduct spring (early April to mid-June) electrofishing surveys at a variety of sites along the 74 mile section of the upper river. No less than 5 sites should be surveyed, with primary sites at Allisonia, Foster Falls, Shot Tower Falls, Ivanhoe, and Fries. If time and manpower are available, secondary sites at Route 100, Carter's Falls (aka Bertha Shoals), Austinville, and Byllesby Reservoir should be surveyed as well. If possible, a minimum of 1 hour sampling time (four 900 second runs) should be conducted at each site.
c) Conduct fall night electrofishing surveys in upper Claytor Lake and Byllesby Reservoir to evaluate young of the year survival following spring stocking if time and manpower are available.
d) Conduct a peak season (February to April) Walleye angler survey from Allisonia to Buck Dam every 5 to 7 years to document angler catch and harvest of walleye if time and manpower are available.
e) Evaluate the relative contribution of natural reproduction and supplemental stocking using a mark/recapture technique after 5 years of increased female spawning stock due to the year-round protective slot length limit implemented January 1, 2021.

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Virginia's Muskellunge Management Plan

2020 – 2025

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VDWR Warmwater Streams Committee

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Introduction

Muskellunge (*Esox masquinongy*) have been stocked in many waters throughout Virginia and have developed into popular sport fisheries that provide anglers the opportunity to catch a trophy fish. Although native Muskellunge populations exist in the upper Tennessee River drainage, this historical distribution is not thought to include Virginia (Jenkins and Burkhead 1994). Therefore, the presence of Muskellunge in Virginia is considered to be solely the result of hatchery introductions, including waters within the Tennessee River, Big Sandy River, and New River drainages as well as waters throughout the remainder of the state. The purpose of this plan is to summarize the current status of Muskellunge management in Virginia and to provide goals, objectives, and strategies to manage Muskellunge populations into the future.

The Virginia Department of Wildlife Resources (VDWR), formerly the Virginia Department Game and Inland Fisheries, began stocking Muskellunge in various waters throughout the state in 1963. VDWR currently recognizes 19 waters as having existing muskellunge populations, which include 9 rivers and 10 impoundments (Table 1). These populations are maintained by annual stocking or through natural reproduction following previous introductions.

Wingate (1986) identified four primary goals that have historically been pursued in the management of Muskellunge in North America. These goals include 1) producing trophy fisheries, 2) providing diversity to angling opportunities, 3) providing top-down predator control of fish populations, and 4) protecting and restoring endemic Muskellunge populations. With the exception of the final goal listed, these are the same

goals that have been, and continue to be, followed in the management of Muskellunge in Virginia.

Most naturalized populations of Muskellunge in Virginia exhibit low population density and are primarily managed as Class C fisheries with the goal of adding diversity to angling opportunities (Table 1). These waters do not receive annual stockings and are managed under relatively liberal length limits. The two exceptions to this are the James and New River populations both of which are self-sustaining and relatively dense in terms of Muskellunge abundance. Additionally, these waters exhibit great trophy potential and have become destination fisheries and as such are considered Class A Muskellunge waters. The Shenandoah River and the South Fork Shenandoah River are also considered Class A Muskellunge waters, but require stocking to maintain these fisheries. The remainder of stocked waters are considered Class B Muskellunge waters and are managed to provide diverse or trophy angling opportunities or, in the case of Rural Retreat Lake and Lake Shenandoah, for top-down predator control of a stunted Black Crappie (*Pomoxis nigromaculatus*) fishery.

Biology

Muskellunge inhabit both lakes and rivers where they prefer cover such as vegetation, woody debris, bars, and rock outcroppings. In rivers, Muskellunge prefer deep pools or other areas with slower-moving water. The optimal temperature range for Muskellunge is 62° - 77°F with reduced feeding occurring at temperatures above 84°F (Jenkins and Burkhead 1994).

Muskellunge typically reach sexual maturity at 3-4 years for males and 4-5 years for females. Spawning generally occurs in mid-April to early May, although pre-spawning movements may begin in late March (Younk et al. 1996). Spawning generally occurs at water temperatures of 55 – 62°F.

Muskellunge are top aquatic predators with diets composed primarily of other fish species. Although recently hatched fry will prey upon zooplankton and other invertebrates, they quickly switch to minnows and other small fish. As the Muskellunge grows it will switch to preying on larger and larger fish. Diets of adult Muskellunge may also include small birds, mammals, and amphibians. It is this aggressive, predatory nature that has often left other stakeholders with the perception that Muskellunge have a negative impact on native game fish species. Despite the popularity of Muskellunge fishing among many anglers, the development of these fisheries in Virginia has not been without similar conflict. In the case of the New River, as the Muskellunge fishery expanded anglers targeting Smallmouth Bass grew concerned that large Muskellunge were feeding heavily upon Smallmouth Bass and negatively impacting catch rates. To specifically address these concerns, VDWR contracted research aimed at assessing the potential impact of Muskellunge predation on Smallmouth Bass in the New River.

Brenden et al. (2004) found that, although Smallmouth Bass were found in the stomachs of New River Muskellunge, that Smallmouth Bass comprised just 4% (by weight) of Muskellunge diets overall. This study did find that Smallmouth Bass comprised a higher percentage (11% by weight) of the diet for larger Muskellunge (≥ 32 inches). However, this was still less than the percentages contributed by suckers (22%), minnows (24%), or sunfish (20%). These findings were consistent with other

Muskellunge diet evaluations (Deutsch 1986, Bozek et al. 1999) and, as a result, Brenden et al. (2004) concluded that predation by Muskellunge likely did not have a major impact on the New River Smallmouth Bass population. These authors did warn, however, that if VDWR altered their Muskellunge stocking protocols in a way that increased post-stocking survival of Muskellunge then the potential for a negative impact on Smallmouth Bass may be greater.

With changes to the management of Muskellunge in the New River (increased minimum length limit and increased stocking length) beginning in 2006 and a concurrent decline in New River Smallmouth Bass abundance, concerns over Muskellunge predation were raised again. Doss (2017) found that despite a fourfold increase in the abundance of adult Muskellunge since 2006, the contribution of Smallmouth Bass to Muskellunge diet was lower (3%) compared to that observed by Brenden et al. (2004). The importance of other species (suckers, minnows, sunfish) to the diet of Muskellunge was similar between the two studies.

Muskellunge growth can vary substantially among locations and is highly dependent on the availability of suitable prey (Cook and Solomon 1987). A strong sex-dependent difference in growth is apparent in Muskellunge with females growing faster and reaching a larger size than males. Growth estimates for Muskellunge in Virginia are limited to just two river systems, the Shenandoah River and the New River (Table 2). Brenden (2005) estimated that both male and female Muskellunge reached 30 inches by Age 3. At Age-6 the differences in growth became more apparent with males averaging 40 in and females averaging 43 in. By Age-8, females had reached a length exceeding 45 in while males averaged 41 in. Following the implementation of a 42-inch

minimum length limit (MLL) in 2006, however, Doss (2017) observed reduced growth for Muskellunge in the New River. Both male and female Muskellunge were found to take an additional year to reach a particular length when compared the Brenden (2005) study. The author attributed this to increased intraspecific competition for forage resulting from higher Muskellunge density under the higher length limit.

In general, advanced age at maturity and low population density can make Muskellunge populations particularly vulnerable to exploitation and can limit the potential for trophy production (Casselman et al. 1996; Crane et al. 2015). Brenden (2005) estimated the annual exploitation rate of New River Muskellunge to be 14%, which was substantially lower than the rate (25%) suggested by Hanson (1986) as a maximum threshold for quality Muskellunge management. More recent investigations indicate that while angler utilization in terms of catch is high (defined as percentage of tagged fish caught; James River ≥ 50% and New River ≥40%), exploitation in terms of harvest is low (James River ≤ 5% and New River = 0%; VDGIF unpublished data).

Regulations

Nearly all Muskellunge fisheries in Virginia are managed under a 30-inch minimum length limit and a 2-fish daily creel limit. The only exceptions to this are regulations developed for the New River and Lake Shenandoah aimed at reducing harvest and increasing the abundance of large Muskellunge. The Muskellunge population in Lake Shenandoah is managed under a 40-inch MLL and 1 fish per day creel limit. In 2006, the MLL for the New River fishery was increased from 30 in to 42 in and the daily creel limit was reduced to 1 fish per day. Doss (2017) concluded that the 42-in MLL resulted

in an increased abundance of larger (≥42 in) Muskellunge in the lower New River (Claytor Dam to the WV state line). Concurrent with the increase in large Muskellunge, however, was a reduction in growth and condition of fish between 35 and 40 in, likely due to stockpiling. As a result of this research, VDWR implemented a seasonal 40 to 48 in protected slot limit (PSL) in 2017 with the intent of reducing intraspecific competition for fish <40 in through harvest while at the same providing additional protection for larger fish. From June 1 through the last day of February, no Muskellunge between 40 and 48 inches may be harvested. During the spawning period (March 1 – May 31) the regulation switches to a 48-in MLL to protect more spawning adults. The 1 fish per day creel limit remains in effect year-round for Muskellunge on the lower New River. Muskellunge in the upper New River (Fields Dam downstream to, and including, Claytor Lake) are still managed under the 42-in MLL.

Monitoring

Differences among the various systems where Muskellunge are present make it difficult to establish standardized sampling protocols and none will be included in this plan. However, biologists managing waters that receive annual or periodic stockings of Muskellunge should make an effort to evaluate stocking efficacy. In particular, relative post-stocking survival and growth should be determined. Priority fisheries that are maintained through natural reproduction should be sampled annually to provide an indication of recruitment. Most creel surveys currently conducted by VDWR on Muskellunge waters do not accurately capture levels of directed effort, catch, or harvest for this species. Typically, creel surveys are conducted only during the peak spring-

summer fishing season. However, much of the targeted effort for Muskellunge occurs fall – spring.

Production & Stocking

Initially, VDWR obtained Muskellunge eggs or fry from a number of states (New York, Pennsylvania, Tennessee, and West Virginia) for introduction into Virginia waters. Over the years, the agency has shifted to collecting brood fish from Virginia waters for in-house production of Muskellunge fingerlings. Additional eggs or fingerlings have been periodically obtained from other states (New Jersey and North Carolina) in years in which in-house production was not sufficient to meet the requested allocation. With the implementation of more stringent biosecurity measures by VDWR, New Jersey and North Carolina are now the only states from which VDWR may obtain surplus Muskellunge.

The mean length of Muskellunge fingerlings produced for stocking was initially 4-6 in for all state resources. Standard stocking rates at this size were established at 1-3 fish/acre of surface area for impoundments and approximately 1-2 fish/acre of pool habitat for rivers. In 2007, the VDWR Aquaculture Science Team made the decision to switch to stocking advanced fingerings (8-12 in) with the goal of increasing survival and reducing strain on hatcheries. By switching to advanced fingerlings, hatchery staff could stock less fish and require less hatchery pond space in the process. As a result of this decision, river and impoundment stocking rates were reduced by half to account for improved survival (0.5-1.0 fish/acre of pool habitat for rivers and 0.5-1.5 fish/acre of surface area for impoundments).

The current number of advanced fingerlings needed for statewide stocking is approximately 1,780 fish annually. Despite the relatively low number of fingerlings needed, these fish can be incredibly challenging and costly to raise. Limited hatchery tank or pond space, the high cost of forage for fingerlings, and unpredictable environmental conditions and resulting variable survival of fingerlings in rearing ponds can greatly affect the final number of fingerlings produced as well as the cost per individual fish. Table 3 provides a general breakdown of costs associated with the production of advanced Muskellunge fingerlings by VDWR. Total annual production cost is estimated at just over $30,000 with the purchase of minnows for feeding the fingerlings after they are stocked into the rearing pond accounting for nearly 60% of the total cost. This value is based on a single 5-acre pond with a maximum fingerling production of about 1,500 fish. If the pond is successful and the maximum number of fingerlings are produced, the production cost is around $20.36/advanced fingerling. As pond success decreases the cost per fingerling increases and can be about $40.73/advanced fingerling if the pond only produces half of the maximum.

Biologists and hatchery staff work together to collect broodstock muskellunge in March and April with a target of three ripe females and about 2 to 3 males per female. The primary muskellunge brood source for VDWR is currently the James River, although alternate sources (e.g. New River, Rural Retreat Lake, and Hungry Mother Lake) have been used historically and are still available if needed. Brood fish are transported directly to Vic Thomas Fish Hatchery (VTFH) due to its nearness to the James River and the availability of large holding tanks at VTFH. The availability of the large holding tanks allows for Muskellunge to be held and periodically checked for

ripeness. Fertilized eggs (typically 150,000–200,000) are transported to Buller Fish Hatchery (BFH) for hatching and grow-out. The transfer to BFH is necessary because rearing Muskellunge at VTFH would conflict with Striped Bass (*Morone saxatilis*) production at that facility. The need to strip and fertilize eggs at VTFH is necessary because holding space for adult fish is limited at BFH. Currently, just one 5-acre pond is allocated for Muskellunge production at BFH with a maximum production capacity of approximately 1,500 advanced fingerlings. As a result, current VDWR production capacity for advanced Muskellunge fingerlings is insufficient to cover annual stocking requests for existing waters and prohibits the development of new Muskellunge fisheries.

Given the potential for insufficient hatchery production, it is imperative that VDWR establishes stocking priorities each year prior to the Muskellunge production season. These priorities will be established by the Muskellunge working group within the VDWR Warmwater Streams Committee and will be maintained in a “living” spreadsheet that will accompany this plan. The working group includes both hatchery personnel and field biologists. Class A waters (lower New River, James River, Shenandoah River, and South Fork Shenandoah River) will be assigned the highest stocking priorities each year based on the popularity of these fisheries. However, with the self-sustaining nature of the lower New River and James River fisheries, stocking will only be necessary when problems with recruitment become apparent through annual monitoring. If stocking is not necessary in the New River or James River, then the remaining Class A waters will receive the highest stocking priority followed by Class B waters. Whether or not a particular Class B water received Muskellunge fingerlings the previous year as well as

the proximity of a particular water to a population center will be the primary criteria used to establish annual stocking priorities within the Class B management category. Logistic constraints associated with the harvest and transport of fingerlings can be used to adjust priorities annually as needed.

Program Justification

Given the challenges and costs associated with maintaining Virginia's Muskellunge fisheries, it is imperative that these efforts are in line with, and contribute to, VDWR's overall mission. More specifically, it is important to consider how Muskellunge fisheries contribute to the agency's efforts aimed at recruiting, retaining, and reactivating (R3) participation in outdoor recreation.

Muskellunge are a challenging and exciting species for anglers to target, but fishing for them is not for everyone. Known as "the fish of 10,000 casts", it takes dedication, research, and some specialized equipment and techniques for anglers to be successful. Costly, complex, and extreme types of fishing are generally considered barriers to recruitment of new anglers to fishing (Aquatic Resource Education Association 2016). For new anglers, the opportunity for relaxation is a strong driver for participation and as a result may not be attracted to the challenges associated with Muskellunge angling (American Sportfishing Association 2012a; Recreational Boating and Fishing Foundation and the Outdoor Foundation 2015). However, more experienced or avid anglers generally seek greater excitement and challenge and may become more specialized in their angling activity. Additionally, Muskellunge are one of the few sport fish in Virginia that are actively feeding during the winter months and most dedicated

Muskellunge anglers believe that this is the best time of year to target these fish. The additional wintertime angling opportunities provided by Virginia's Muskellunge fisheries have the potential to increase angler retention and reduce churn rate by increasing the number of days per year a person fishes (Aquatic Resource Education Association 2016).

Therefore, while VDWR's Muskellunge program may not serve as a primary option for recruiting new anglers, this program has tremendous potential to advance the other two components of R3, retention of existing anglers and reactivation of lapsed anglers. While VDWR focuses substantial effort toward recruiting new anglers through events like free fishing weekends and kids fishing days, there are few programs solely devoted to retaining and reactivating anglers. The Muskellunge program could function as one of the tools used to prevent angler lapse and serve as a blueprint for other programs ill-suited for recruitment. By marketing the program to current and lapsed anglers, we have the opportunity to reduce churn rate (the annual level of anglers that lapse in the activity) and reactivate disinterested anglers.

Evaluation

The Muskellunge working group will meet regularly to evaluate the effectiveness of current Muskellunge management practices. If evaluations of specific waterbodies yield poor results a change of the classification of a given fishery will be considered. The working group may make recommendations to increase sampling effort or change stocking rates in an effort to improve an ailing population. Hatchery production will also

be routinely evaluated and fine-tuned to improve yields. If yields improve, efforts will be made to increase muskellunge fishing opportunities.

The committee will critically evaluate success in meeting stakeholder related goals as well as the success or failures of outreach efforts related to R3. Changes will be discussed and enacted as deemed appropriate by the Muskellunge working group.

Goals

Goal 1: Maintain and enhance recreational fishing opportunities for Muskellunge with consideration of associated fish assemblages and aquatic communities.

Objective 1. - Maintain and protect existing self-sustaining Class A Muskellunge fisheries.

Strategies

- Closely monitor populations to detect potential problems with recruitment, growth, or mortality.
- If problems with recruitment are detected, divert hatchery production of advanced fingerlings to these fisheries in accordance with the prioritized stocking list outlined in this plan.
- Implement regulations as needed to maintain a sustainable level of exploitation (≤25%).

Objective 2. – Maintain and protect existing self-sustaining Class B Muskellunge fisheries.

Strategies

- Adhere to the prioritized stocking list outlined in this plan to most effectively utilize hatchery production of fingerlings.
- Implement regulations as needed to maintain a sustainable level of exploitation (≤25%).

Objective 3. - Insure sufficient hatchery production of advanced Muskellunge fingerlings sufficient to maintain stocked fisheries.

Strategies

- Adhere to the prioritized stocking list and stocking rates outlined in this plan to most effectively utilize hatchery production of fingerlings.
- Explore potential for tank rearing of advanced fingerlings as a means to reduce variability in annual hatchery production and reduce costs.
- Work with VDWR Veterinarian to identify additional states that may serve as a source for Muskellunge fingerlings.
- Review existing Muskellunge stocking rates to insure optimal utilization of annual hatchery production.
- Support overall efforts to improve VDWR's statewide hatchery production capacity.

Objective 4. – Increase Muskellunge fishing opportunities statewide through development of new waters or enhancement of existing Muskellunge fisheries.

Strategies

- Evaluate the potential of more restrictive regulations such as higher minimum length limits to increase Muskellunge density in existing self-sustaining Class C waters.
- Create list of potential new Muskellunge waters that could be created if hatchery surplus is available. These waters would only be stocked after all other existing waters are stocked.

Goal 2: Use science-based management for Virginia's Muskellunge fisheries.

Objective 1. – Establish a standing Muskellunge working group to assist the Fisheries Chief in addressing management issues. This group will be a sub-committee under the Warmwater Streams Committee.

Strategies

- Conduct a review of Muskellunge stocking rates currently employed by VDWR.
- Evaluate the feasibility of implementing an angler diary program for estimating Muskellunge catch rates and size structure on particular waters or statewide.
- Develop a list of research and information needs for maintaining Virginia's Muskellunge fisheries.

Objective 2. – Improve current monitoring efforts directed at existing Muskellunge fisheries.

Strategies

- Design future creel surveys conducted on major Muskellunge fisheries to cover the important fall-winter period to allow for improved estimation of directed effort as well as catch and harvest rates.
- If feasible, implement an angler diary program for estimating Muskellunge catch rates and size structure.
- Monitor exploitation rates on major Muskellunge waters through tagging studies.
- Conduct directed annual sampling on Class A Muskellunge fisheries, especially those that are sustained through natural reproduction.
- Collaborate with Muskies Inc. Chapter 76 (Virginia) to assist with monitoring and research efforts.
- Develop and maintain a list of fishing guides targeting Muskellunge in Virginia. This list could serve as an important source of

information such as catch and usage, economic impact, and other issues related to these fisheries.

Goal 3: Foster improved communication to promote the recreational value of Virginia's Muskellunge fisheries and minimize conflict among stakeholder groups.

Objective 1. – Improve communication efforts relating to Muskellunge fisheries in Virginia.

Strategies

- Maintain most current Muskellunge information on VDWR website. https://www.dgif.virginia.gov/wildlife/fish/muskellunge/
- Promote Muskellunge webpage and "Musky 101" video through social media and email campaigns.
- Collaborate with Muskies Inc. Chapter 76 (Virginia) to assist with communication efforts.

Objective 2. – Promote Virginia's Muskellunge fisheries as a means to maximize utilization of these resources.

Strategies

- Market the Muskellunge program to anglers as a way to extend their fishing season.
- Utilize targeted marketing in population centers with nearby Muskellunge fisheries to inform the public about trophy fishing opportunities available to them.
- Promote the Muskellunge webpage and "Musky 101" video through social media and email campaigns as a means to attract anglers to the sport of Musky fishing.
- Collaborate with neighboring states to create a "Southern Musky Trail" and market to northern anglers to fish southern waters in the winter when their resources are iced over or in spring when they are closed to fishing.

Objective 3. – Utilize Muskellunge fishing as an integral part of VDWR's efforts to retain current anglers and re-activate lapsed anglers.

Strategies

- Market the Muskellunge program to current anglers as a way to extend their fishing season.
- Promote the Muskellunge webpage and "Musky 101" video through social media and email campaigns as a means to attract anglers to the sport of Musky fishing.
- Collaborate with neighboring states to create a "Southern Musky Trail" and market to northern anglers to fish southern waters in the winter when their resources are iced over or in spring when they are closed to fishing.

- Email link to VDWR's Muskellunge webpage directly to lapsed anglers in an effort to reactivate them by offering a new angling challenge.
- Collaborate with Muskies Inc. Chapter 76 (Virginia) to assist with recruiting new anglers, educating the public, and participating in ongoing research.

Table 1. – List of existing Muskellunge waters in Virginia. Class A waters are considered trophy Muskellunge destination waters. Class B waters provide good fishing opportunities for Muskellunge, although catch rates and trophy potential is generally lower than Class A waters. Class C waters support fishable Muskellunge populations, although they do not contribute a significant part to the overall fishery.

	Area (acres)	Stocked/ naturalized	Management classification	Stocking allocation	Regulations
Rivers					
Clinch River	790	naturalized	C	**	statewide
Cowpasture River	**	stocked	C	**	statewide
Jackson River	**	stocked	C	**	statewide
James River	1,644	naturalized	A	822-1,644	statewide
New River	3,064	naturalized	A	1,202-2,403	special
Powell River	**	naturalized	C	**	statewide
SF Shenandoah River	828	stocked	A	414-828	statewide
NF Shenandoah River	196	stocked	B	98-196	statewide
Shenandoah River	384	stocked	A	192-384	statewide
Impoundments					
Burke Lake	218	stocked	B	109-327	statewide
Claytor Lake	4,475	naturalized	C	**	statewide
Flannagan Reservoir	1,143	naturalized	C	**	statewide
Hungry Mother Lake	108	stocked	B	54-162	statewide
Lake Shenandoah	36	stocked	B	18-54	special
North Fork Pound Lake	154	naturalized	C	**	statewide
Ragged Mountain Reservoir	170	stocked	B	85-255	statewide
Rural Retreat Lake	90	stocked	B	45-135	statewide
Smith Mountain Lake	20,600	naturalized	C	**	statewide
South Holston Reservoir	1,600	naturalized	C	**	statewide

Table 2. – Mean length-at-age (inches) for Muskellunge from two Virginia rivers. Populations in the New River (2000-2003) and Shenandoah (2014) were managed under a 30-inch minimum length limit (MLL) at the time of data collection while the New River (2013-2016) population was managed under a 42-inch MLL.

	New River[1] (2000-2003)		New River[2] (2013-2016)		Shenandoah River[3] (2014)
Age	**Female**	**Male**	**Female**	**Male**	**Combined**
2	27	29	20	23	25
3	33	34	27	28	30
4	38	37	32	32	34
5	41	39	37	35	37
6	43	40	40	37	40
7	44	41	43	39	42
8	45	41	45	40	43

[1] from Brenden (2005)
[2] from Doss (2017)
[3] VDWR (unpublished data)

Table 3. – General costs of producing and stocking advanced Muskellunge fingerlings by VDWR. Values given are based on a single 5-acre pond with a maximum fingerling production capacity of 1,500 fish.

Category	**Cost**
Labor (416 hours @ $20/hour)	$8,320
Supplies	$3,078
Forage (minnows)	$17,900
Transportation	$1,248
Total	$30,546

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Appendix 1 – Detailed Muskellunge Egg Collection & Fertilization Procedures

1) Collecting Brood Fish

a) Collect three females 35 to 45 inches in total length when river temperature reaches about 55°F, preferably during a warming trend.

b) If a ripe female is found skip to step 6.

c) Unripe fish will be injected with Common Carp Pituitary Gland powder (CCP).

2) CCP Preparation

a) Remove cap from specimen cup and place it on the table face up (outside of lid touching table). Weigh out 0.15g (150mg) CCP powder using sterile spoon to scoop CCP powder directly into sterile specimen container. Replace cap and label specimen cup. Store at room temperature and avoid light.

3) Reconstitution of CCP

a) Attach an 18 gauge (green) needle to a 35ml syringe. Fill syringe with 20ml sterile water. Remove cap from specimen cup and place it face up (outside of lid touching table). Add sterile water to specimen cup with CCP powder. Put the needle in sharps container. Replace specimen cup lid and shake. Use within one hour of reconstitution. Discard remainder of reconstituted CCP in the regular trash.

4) Intracoelomic (IC) Injection

a) Use anesthesia gloves to control females during injection.

b) Weigh the fish you plan to inject

c) Use 12ml syringe with 20 gauge needle (Pink) for fish injections. Fill syringe with amount of CCP solution based upon the injection chart (Column C). Place fish on dorsum. Insert needle at 45 degree angle just off the midline anywhere between the following landmarks: halfway between the pelvic and anal fins but proximal to the anal pore. (Inject in the pocket behind the pelvic fin). Plunger should be easy to depress if the needle is in the body cavity. If difficult to depress, re-insert the needle to find the body cavity. Discard needle in sharps container.

d) Place fish into musky holding pen. Check ripeness in 3 days.

5) Collecting Milt

a) Collect 3 males 35-40” for each female in holding.

b) Use anesthesia gloves to control fish

c) Disinfect the fish’s vent with a 1:100 (10ml per liter) iodophor solution and wipe the vent surface dry with a clean paper towel.

d) Express male and collect milt using sterilized plastic syringe. Deposit milt in sterile vial. Avoid collecting urine in sample.

6) General Procedure for Fertilization and Egg Disinfection

a) For spawning use three people, one to control the head, one to anesthetize the fish, and the other to strip the female.

b) Disinfect the fish's vent with a 1:100 iodophor solution (10ml per liter) and wipe the vent surface dry with a clean paper towel. Spawn eggs into a clean, dry pan and add milt from 2-3 males to fertilize the eggs. Gently stir the eggs with a clean turkey feather to ensure full distribution of the milt throughout the mass of eggs. Add de-chlorinated distilled water and mix to ensure milt activation (1-2 minutes). Keep eggs in an ice bath to keep eggs cool (15 degrees C).

c) Rinse excess milt and any blood or feces off the eggs with a large amount of de-chlorinated distilled water.

d) If the eggs are adhesive and require use of a de-adhesive agent (i.e., walleye), add tannic acid or Fullers earth from a stock solution and mix gently, but thoroughly. Stir for approximately 2 minutes. Caution: Fuller's earth and tannic acid have been commonly used as an anti-clumping agent for cool water species. Published research suggests that when tannic acid is combined with iodophor, tannic acid destroys the ability of either compound to effectively inhibit VHS, Type IVB. Thorough rinsing of both de-adhesive agents is required to ensure that it does not interfere with the disinfectant properties of iodophor. We typically do not use Fullers Earth or Tannic Acid in the spawning process, clumping has not been a huge issue

e) Gently pour off the solution and gently rinse eggs with clean, de-chlorinated distilled water.

f) Immediately but gently add the prepared solution of 50 ppm iodophor (5ml per liter of distilled water) and gently mix to ensure even distribution of iodine to the egg mass. Disinfect for 30 minutes out of light. Keep eggs in an ice bath to keep eggs cool – match the temperature of the water used to hold brood fish (typically 15 C).

g) Gently rinse eggs with de-chlorinated distilled water into waste bin. Place eggs into de-chlorinated distilled water to complete water-hardening. Pour into transport bag and add air for shipping. Ship in dry cooler with a few cubes of ice to hatchery.

h) Clean, disinfect and dry all potentially contaminated equipment used in the disinfection process.

7) Equipment Disinfection

a) Remove organic debris from equipment using tap water, detergent, and scrubber or sponge.

b) Fill plastic container with desired amount of water. Add enough Chlorhexadine to turn water sky blue color.

c) Let equipment sit for 10 minutes, then rinse and dry.

Equipment Checklist

- Plastic syringes for milt extraction
- Syringes for CPP injection
- 3 egg pans
- Musky holding pen, 4 weights, 8 ropes, 4 floats. Sign.
- Anesthesia Gloves
- Musky Socks / Musky Nets
- Measuring Cups
- Feathers
- Premeasured CPP
- Distilled water
- Iodophor
- Timers
- Oxygen Tank**,** Banding Tool, Bands, Egg Bags, Large Cooler
- Biohazard Container

Appendix 2 – Detailed Muskellunge Hatchery Rearing Procedures

Egg Transfer and Acclimation

Musky are strip spawned at Vic Thomas Fish Hatchery. Fertilized eggs are then placed in plastic bags with water and compressed oxygen and sealed with rubber bands. Eggs water harden during the 3 hours it takes to transport them to Buller Fish Hatchery. Once eggs are received they are poured into plastic containers to start the water temperature acclimation process. Well water at 54F is poured into each plastic container gradually to slowly cool down eggs. Temperature is monitored as well water is added to each container. The acclimation process takes approximately 30 minutes to get the water temperature down to 54F.

Egg Incubation, Enumeration, Treatment, and Hatch

Once acclimation is complete musky eggs are poured into McDonald jars and are separated by spawning batches. Initial volume of eggs in each jar is recorded after eggs settle to the bottom of the jars. Water flow is then adjusted for each jar until the eggs are rolling properly. Water flow is usually set between 1gpm and 1.5gpm depending on the amount of water needed to roll eggs. Eggs are continuously monitored throughout the incubation process to make sure they are moving appropriately in each jar.

The next day eggs are sampled from each jar to determine an estimation of the number of eggs per ounce. Eggs are collected by using a siphon tube with a bulb on the end, they are then transferred to a Von Bayer trough where 3 inches of eggs are placed in a line and counted. Three inches is then divided by the number of eggs in the count, this will give a diameter or measurement of each egg. For example, if you have 35 eggs within 3 inches in the trough, the egg diameter is .085. This number is then used to look up how many eggs you have per ounce using the Von Bayer egg chart. Musky eggs generally range between 1900-2100 per ounce depending on the size of the female. To get the total estimation of eggs per jar, the number of eggs per ounce is multiplied by the total ounces in each jar. Fertilization estimates are also taken 4 days post fertilization by counting good eggs and the total number of eggs in a clear tube and a percentage of viable eggs is calculated.

Treatment of eggs is initiated two days after they are received. Hydrogen peroxide is used at 500ppm to reduce or eliminate saprolegnia fungus that will cover eggs if left untreated. Eggs are treated every other day for 15 minutes using a flow through treatment. Treatment is calculated by using the following formula [water flow (gpm) X treatment duration (min) X treatment concentration (mg/L) / % Active Ingredient x Correction factor/ specific gravity]. For example, treatment of musky eggs, water flow 1 gpm for 15 minutes at 500 ppm [1gpm x 15 x 500ppm/ .35 AI x .003785 CF / 1.132 SG]

= 72 ml hydrogen peroxide. Dead eggs are siphoned from jars daily throughout the incubation period to help reduce fungus.

A few Eggs will begin to hatch at 8 to 9 days at 54F post fertilization. Once hatch is observed egg treatment is discontinued and eggs are transferred to wire mesh trays placed in 300 gallon rectangular tanks. Hatching will continue for up to 15 days or 342 temperature units. The water temperature in the rectangular tanks is the same temperature 54F. Any fungus clumps or unfertilized eggs should be removed from the screen tray platform to help reduce the spread of fungus to sac fry. Sac fry that hatch on the wire mesh tray are fanned using a turkey feather to encourage them to swim off the screen tray. Once the majority of live sac fry have swam off the platform the platform trays are removed.

Fry Tank Production

Fry generally take 7-10 days to absorb their yolk sac and swim up. During this time frame, and throughout the fry tank production period, musky are treated prophylactically every other day with a formalin static bath at 150 ppm. This is done to reduce fungus. Temperature is gradually increased via inline heater to 68F. Water flow is set between 1 and 3 GPM in each tank.

Once fry are observed swimming, brine shrimp are cultured. Brine shrimp are hatched using six 15 gallon culture units. Artificial light is left on 24 hours per day. A space heater in the brine shrimp room heats water to 84F and salinity is adjusted to 28 ppt. Brine shrimp will hatch, and are harvested, 24 hours after setup. Only one 15 gallon brine shrimp cone is used per 24 hour hatch period. Water is always filled 24 hours before eggs and salt are added to allow time for the water to heat.

Musky are hand fed Brine shrimp 7 to 8 times per day per tank. Otohime feed is mixed with brine shrimp at each feeding. Musky are fed for the last time in the evening around 9 pm, belt feeders are setup to feed otohime feed overnight. Each tank has a 4 foot led shop light left on 24 hours per day to help with visual feeding. Fry are fed otohime and brine shrimp for 14 days post swim up.

Tanks are cleaned twice per day once in the morning and once in the afternoon. Cleaning tanks is labor intensive and requires patience. Tanks are swept with a broom to concentrate leftover feed to one end of the tank, unfortunately musky are also swept with the leftover feed. When the waste is siphoned so are musky fingerlings and they have to be picked out with a net. Water exchanges should also be done once a week. The sides and bottoms of the tanks should also be wiped daily with a wash cloth to remove fungus and slime. The standpipe area of the tank should also be siphoned and wiped twice a week.

Fry are fed for approximately two weeks before they are sampled and transferred to a 5 acre production pond. If fry are held longer than two weeks in tanks, cannibalism

causes major fry loss. Fry are acclimated to pond water and are spread out in different locations throughout the pond. The pond should be stocked with 5,000 musky fry per acre.

Pond Production and Fertilization

Pond #2 (5 acres) is filled around the 1st week in March. Brood minnows are ordered (500lbs.) and delivery is scheduled for the last week in March or the 1st week in April. Brood minnows are fed 3 times per week with small trout feed pellets. Two weeks prior to stocking musky fry, the pond is fertilized with 50lbs. of soybean meal, 50lbs of Alfalfa meal and 8 lbs. of granular pond fertilizer per acre. Fertilization is done to provide a zooplankton bloom to fathead minnow fry and musky fry. The fertilization regimen should continue once a week through the end of June, then should be switched to 5lbs of granular pond fertilizer per acre until harvest in September.

The second shipment of fathead minnows should be delivered around the 3rd week in June. The minnows should be small in size (700lbs.). The third shipment of fathead minnows should be delivered during the third week in July. The minnows should be pond run (700lbs.). The fourth shipment of minnows supplied by King and Queen Fish Hatchery should be delivered by the third week in August (300lbs.).

Harvest

Musky are generally harvested during the second or third week in September. The 5 acre production pond takes 7-8 days to drain, heavy boards are pulled one at a time. Water flow is decreased but maintained throughout draining. Musky are drained into two concrete spillways with screens placed in the back slots of each spillway. Boards are placed in slots behind the screens to maintain water level in the spillway. Many musky have to be picked up by hand in the pond because they get stuck in aquatic vegetation and don't make it to the drain channels. Musky that have been picked up by hand are placed in 5 gallon buckets with bait aerators and then transferred to a fish hauling truck. Harvesting musky is very labor intensive and requires a crew of 10-12 staff. Harvested musky are counted from the hauling truck to the hatchery building and are separated by stocking locations. Musky are allowed to rest overnight in the hatchery building before being sampled and shipped to stocking locations throughout the state.

Cost Analysis of Musky Production

LABOR ESTIMATE

Collection and Spawning= 48 hours

Transport of eggs= 10 hours

Tempering and setting eggs= 3 hours

Egg Treatment= 6 hours

Egg checks, fertilization rates etc. = 4 hours

Tank Setup heater, pumps and screens= 4 hours

Treatment of Musky Fry= 4 hours

Cleaning and feeding @3weeks =110 hours

Pond prep, setup and draining= 40 hours

Pond fertilization and feeding minnows= 32 hours

Administrative, planning, ordering minnows, data etc. = 10 hours

Harvesting Musky= 105 hours

Stocking Musky= 40 hours

Total Hours= 416 @ $20 per hour Average labor rate without benefits.

Total Labor Cost= $ 8,320

FORAGE COST

Brood Fathead Minnows- 500 lbs. $8.50/lb. = $4,250

Small Fathead Minnows- 700 lbs. $11.00/lb. = $7,700

Pond Run Fathead Minnows- 700 lbs. $8.50/lb. = $5,950

Total Forage Cost= $17,900

TRANSPORTATION COST

Hauling trips

Trip #1- Shenandoah Lake, SF Shenandoah, NF Shenandoah, Main Stem Shenandoah. Round Trip (Verona-Buller-stops-Verona) 576 miles

Trip #2- Ragged Mountain Res, Burke Lake. Round Trip (Front Royal-Buller-stops-Front Royal) 660 miles

Trip #3- Hungry Mother, Rural Retreat Lake. Round Trip (Buller-HM-RR-Buller) 54 miles

Egg transfer- VTFH to Buller, 2 trips 374 miles

Total Mileage= 1664 miles @ $.75 per mile = $1248

SUPPLY COST

Soybean meal- 1500 lbs. @ $.217 lb. = $325.50

Alfalfa meal- 1500 lbs. @ $.319 lb. = $478.50

Pond Max- 640 lbs. @ $1.60 lb. = $1,024

Minnow Feed- 500 lbs. = $300

Chemicals hormones, formalin etc. = $250

INAD= $700

Total Supply Cost= $ 3,078

TOTAL COST MUSKY PRODUCTION 5 ACRES (1500 MAX PRODUCTION) = $30,546

1,000 fish- cost per fish= $30.55

1,250 fish- cost per fish= $24.44

1,500 fish- cost per fish= $20.36

TOTAL COST MUSKY PRODUCTION 10 ACRES (3000 MAX PRODUCTION) = $ 54,114

Extra Cost to add 5 acres of production

Minnows=$17,900

Labor 177 HRS (pond setup, draining, harvesting, and fertilizing) = $3,540

Fertilizer and Feed= $2,128

2,000 fish- cost per fish= $27.05

2,500 fish- cost per fish= $21.64

3,000 fish- cost per fish= $18.04

Striped Bass and Hybrid Striped Bass Management Plan for Virginia Reservoirs

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Introduction

Striped Bass *Morone saxatilis* are an anadromous fish native to Virginia. Their annual spring migrations occur in all major Atlantic slope river drainages with fish ascending from the ocean to tidal freshwater below the fall line to spawn (Jenkins and Burkhead 1994). They have tremendous economic value fueling substantial recreational and commercial fisheries. Striped Bass and their hybrids (typically a female Striped Bass crossed with a male White Bass *M. chrysops* in a hatchery) are widely stocked into Virginia reservoirs (for purposes of this management plan, "reservoirs" are those impoundments exceeding 500 acres vs. "small impoundments"). This management plan encompasses the use of Striped Bass and Hybrid Striped Bass (hereafter referred to simply as "hybrids") in Virginia reservoirs.

Striped Bass and hybrids have historically been stocked in Virginia reservoirs to provide a diversification of the fishery and exploit unused or marginally used habitat (pelagic zone) and forage (clupeid species; typically Gizzard Shad *Dorosoma cepedianum* and herrings of genus *Alosa*). All Striped Bass populations in Virginia are maintained entirely through stocking (put-grow-and-take fisheries) with the exception of Kerr Reservoir which has some natural reproduction (Jenkins and Burkhead 1994). However, Kerr's natural reproduction and highly variable year classes are not capable of supporting the current recreational fishery.

Striped Bass have been stocked in numerous Virginia reservoirs for decades with fish sourced from both Chesapeake Bay and Roanoke River broodstock. Striped Bass have fairly stringent habitat requirements and require adequate levels of oxygen and thermal regimes within tolerance levels. These requirements change as the fish grows – a phenomena known as

an ontogenetic shift. These parameters during summer months frequently limit Striped Bass habitat in thermally stratified southeastern U.S. reservoirs in a scenario known as "temperature-oxygen squeeze" (Coutant 2013). Generally, this condition is more common in eutrophic systems (e.g., Lake Anna) and less so in mesotrophic reservoirs such as Smith Mountain Lake. In severe situations, acute fish kills can occur; as Striped Bass are sequestered into a thin marginally suitable habitat layer near the thermocline separated from forage. For example, summer Striped Bass kills occurred at Claytor Lake several years between 2002 and 2016 and were attributed to a temperature-oxygen squeeze exacerbated by drought and low flows in the New River.

Striped Bass fish kills have been rare in Virginia. However, even without overt fish kills; poor habitat conditions manifest in reduced growth rates, poor body condition and lowered immunity to fungal, bacterial, and viral infections. Although many studies have described suitable habitat for Striped Bass and hybrids in reservoirs, findings have been generally consistent with regards to the needs of adult Striped Bass. For example, Young and Isely (2004) found Striped Bass avoided temperatures above 25C and dissolved oxygen concentrations below 2.3 mg/l in a South Carolina reservoir, while Cheek et al. (1985) found adult Striped Bass were confined to water with temperature below 24C and dissolved oxygen greater than 4 mg/l in a Tennessee reservoir. All reservoirs exhibit different hydrological conditions and summer thermal stratification patterns. Stocking Striped Bass into reservoirs without adequate summer habitat for adult fish is not recommended. Striped Bass are currently stocked in Lake Anna, Smith Mountain Lake, Leesville Reservoir, Kerr Reservoir, Claytor Lake and the "tidewater lakes"

(Western Branch, Prince and Meade) among others (Table 1). There are several small impoundments also stocked with Striped Bass and hybrids that are not listed in this report.

In reservoirs with marginal or poor habitat, hybrids may be more suitable; as they are more tolerant of degraded water quality conditions and may display "hybrid vigor". However, hybrids are not functionally sterile; and care must be given to ensure stocked fish do not escape into Atlantic slope river systems and corrupt the genetic integrity of anadromous stocks. Thus, hybrids have not historically been stocked in Atlantic slope reservoirs due to concern over escapement, downstream migration, and mixing of *Morone* sp. in tidal waters (this was observed below Occoquan Dam in the tidal Occoquan River in 1989 following hybrid stocking of Occoquan Reservoir). In 2014, hybrids were stocked in Lake Anna (York River drainage) for the first time after VDWR consulted with VMRC and determined that the probability of hybrid escapement from Lake Anna was low. Other stockings followed in subsequent years, and no escapement has been observed (the North Anna River is sampled annually by Dominion Power as part of their North Anna operating permit). Lake Anna remains one of two Atlantic slope reservoirs receiving hybrids and joins Claytor Lake, Carvins Cove and Flannagan Reservoir (Tennessee River drainage) as Virginia reservoirs receiving annual stockings of hybrids. Carvins Cove is the other Atlantic slope reservoir, but any escapees would have to negotiate an extremely unlikely passage through 5 downstream dams to reach tidal water.

As water quality parameters change over time, hybrid stocking may supplement or even replace Striped Bass in some reservoirs. Lake Anna is gradually becoming warmer (Via 2012),

and if trends continue; Striped Bass will not survive. Lake Anna and Claytor Lake have the distinction of being the only two Virginia reservoirs stocked with both Striped Bass and hybrids.

Production/Stocking

Waters stocked, and stocking rates have varied over time; thus production has fluctuated. Some of this was due to rate adjustments in efforts to determine the most appropriate stocking density in a given water (typically standardized as number of fish per acre), as reservoirs differ in productivity, forage base and habitat. One stocking rate does not fit all scenarios. Even within reservoirs, stocking rates are often adjusted based on predator growth rates and/or forage abundance estimates. It is imperative to not overstock predators and deplete clupeid forage and/or reduce abundance of forage species (e.g., Gizzard Shad) within preferred size ranges. Correlations have been documented in Smith Mountain Lake between Gizzard Shad abundance and size structure and Striped Bass abundance. Striped Bass and hybrids are not stocked in reservoirs without clupeid forage. Current stocking rates are listed in Table 1. Striped Bass stocking typically precedes hybrid stocking which may play a role in limited dietary overlap between juveniles during the growing season (Rash and Ney 2013).

Production efforts for Striped Bass are centralized at King and Queen and Vic Thomas Fish Hatcheries. Striped Bass broodstock are typically collected from Chesapeake Bay and Roanoke River drainages in April with resulting progeny stocked into appropriate waterbodies within these watersheds. Historically, hybrids were occasionally produced at DWR hatcheries

when fry were available following fish trades with other states (providing pond space was available), but recently hybrids needed to fill stocking requisitions have been procured via the private sector for approximately $0.40 per 2-3” fish. This trend appears likely to continue.

Current Striped Bass production appears to satisfy statewide demand but is at the upper limit of hatchery capabilities given other warm water production needs and a precarious pond situation at King and Queen Hatchery. There needs to be a plan implemented for putting 11 of 18 dormant ponds back into operation, and input from staff aquaculture personnel should be considered in every step of the planning, bidding and construction processes. Providing adequate maintenance of existing pond space and initiatives to meet deficiencies outlined above, Striped Bass production should meet demand until at least 2026.

In 2020, over 1.63 million Chesapeake Bay and Roanoke strain Striped Bass fingerlings were produced at the King and Queen and Vic Thomas Hatcheries surpassing the requisition of 1.01 million. Two ponds repaired at King and Queen Hatchery in 2020 facilitated the boost in production, and repairs to two others are pending. Use of larger, Phase II fingerlings should theoretically improve survival and may be a useful tool to improve recruitment in some waters. Requests for these fish has been variable (but typically low), and their use is still being evaluated in Region 2. Future production needs for Striped Bass are likely to be stable, as waters with available habitat and forage are already stocked; and new reservoir construction is unlikely. However, demand for hybrids is likely to increase due to popularity and possible expansion of hybrid stocking into Chesapeake Bay drainage reservoirs and small impoundments

with limited emigration potential. In 2020, there were 155, 000 hybrids requested and stocked statewide.

Stocking rates in Virginia reservoirs have fluctuated but have generally been between 5 and 30 fish/acre. Fingerling stockings of Striped Bass are usually conducted in spring at multiple locations (boat ramps) based on reservoir size. For larger systems, three to five stocking locations at mid to upper lake sites are used to better disperse fish and maximize productivity gradients in tributary storage impoundments. Stocking success can be highly variable and has been linked to various biotic and abiotic variables (Sutton et al. 2013). Hybrid stocking usually occurs in summer due to production and bid procurement logistics. When both fish are stocked in the same reservoir, it is beneficial to have stockings temporally separated to maximize survival.

Sampling

Striped Bass and their hybrids are typically sampled during late fall or winter months with monofilament horizontal gill nets in reservoirs (McRae et al. 2013). Some biologists use experimental (multi-panel) nets, while others use (previously standardized) mono-panel nets of various mesh sizes designed to capture young-of-year (YOY) and adult fish. Catch rates are expressed as number of fish caught per net night which will obviously vary based on gear selection. For example, the Lake Anna pelagic fishery is sampled annually with 36 net nights of 200’ experimental gill nets with a resulting Striped Bass mean catch rate of 4.6 fish/net night

(*CV*=38% in 2018, *n*=22). Over the past five years, hybrids added an additional 1.2 fish/net night increasing the overall *Morone* catch rate. Alternatively, Kerr Reservoir was sampled with 18 net nights of 200' mono-panel gill nets in 2018 with a resulting catch rate of 11.7 fish/net night and a CV of 46%. Care must be taken when interpreting catch per effort results to specify gear, as "net night" has not been historically standardized. The term has been equally applied to 100' and 200' nets as well as other lengths.

Otoliths are usually removed from sampled fish for exact age determination to elucidate year class contribution, growth, survival and mortality rates. Growth rates vary substantially among Virginia reservoirs and are largely driven by summer habitat and individual reservoir hydrographic conditions. In a recent study of Striped Bass growth rates in 15 southeastern U.S. reservoirs, Virginia populations ranked from near lowest (Lake Anna) to near highest (Leesville and Claytor Lakes) (Wilson et al. 2013). After age-0, high variability of length at age generally precludes the use of age-length keys.

Creel surveys have documented the importance of *Morone* fisheries to Virginia anglers and local economies. For example, a recently conducted one-year Lake Anna creel survey (2018-2019) estimated 15% of 331,183 angler hours targeted *Morone* populations. Previous surveys at Lake Anna suggested over 20% of users targeted Striped Bass. Seasonal rates were even higher with 83% of directed effort in December targeting *Morone* – popular winter fisheries at many Virginia reservoirs. This same survey demonstrated an overall economic impact of $7.76 million from the 12-month period. Another survey technique - angler diaries -

has been successfully used at Smith Mountain Lake to supplement standard fishery dependent and independent data (Wilson 2013).

Smith Mountain Lake could be called the crown jewel of Virginia reservoir Striped Bass fisheries due to excellent habitat, and a creel survey during a portion of 2014 indicated nearly 40% of all anglers were targeting Striped Bass resulting in an estimated 141,000 hours in just 8 months at this reservoir. However, anglers targeting Striped Bass at Claytor Lake declined from 19% to 6% over the past decade with changes in regional fish populations. It is believed pressure at Claytor Lake was higher when Smith Mountain Lake's Striped Bass fishery experienced a downturn during the early 2000s, and anglers turned their attention to a relatively local alternative. A 2017 9-month creel survey at Kerr Reservoir documented 10% of anglers targeted Striped Bass resulting in an estimated 18,000 hours of angling time. Historically, this figure was higher at Kerr, but the fishery is recovering from a depressed status. The balance of these surveys clearly implicates the great importance of this fisheries across the Commonwealth.

Many, if not most, Striped Bass anglers on Virginia reservoirs are highly specialized (for example; many use high-end electronics, catch their own live bait and troll multiple rigs with planer boards). As specialization increases, dependency on a particular resource also increases; and anglers demonstrate high knowledge and commitment to a resource (Bryan 1977). Thus, these anglers are intuitively valuable candidates to keep satisfied under the agency's "R3" initiative.

Plan Implementation/evaluation

This plan has been, and will continue to be, implemented by District Biologists under supervision of Regional Aquatic Managers (RAMs) amid concurrent oversight of the Reservoir Technical Committee. Success of this reservoir *Morone* management plan will be measured using fisheries-dependent data (primarily fall/winter gill net surveys) to monitor stocking success and population dynamics combined with creel surveys to evaluate angler satisfaction. This plan will be revisited biannually by the Reservoir Technical Committee beginning in 2023.

Table 1. Annual Stocking Rates of Striped Bass and hybrids in Virginia reservoirs.

Reservoir	Size (acres)	VDWR Region	STB/acre	HSB/acre
Chesdin	3100	1	25	
Little Creek	947	1	25	
Western Branch		1	25	
Prince		1	25	
Meade		1	25	
Kerr	48900	2	5	
Gaston		2		
Carvins Cove	800	2		6.2
Smith Mountain	20600	2	15-18	
Leesville	3270	2	15	
Claytor	4363	3	15	7.5
Flanagan	1143	3		15
Anna	9600	4	15	10

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Channel Catfish Management Plan

VDWR Small Impoundments Committee

October 2021

Introduction

Across the United States 8.1 million anglers fish for catfish (USFWS 2016). Channel Catfish are popular sport and food fish that can be pursued by anglers in many small impoundments (Neal and Willis 2012). Stocked at a moderate level, Channel Catfish can complement existing fisheries resources that generally include Largemouth Bass and Bluegill without impacting productivity or growth of those existing populations. Most stocked Channel Catfish have been found to be vulnerable to angling (Masser et. al 1993) and as a result have become quite popular for use in urban fishing programs and kid's fishing events. A nationwide emphasis on R3 (recruitment, retention, reactivation) can also utilize Channel Catfish as both a recruitment tool for new anglers as well as retaining/reactivating current or former anglers.

Generally, in small ponds and lakes with limited aquatic vegetation, juvenile Channel Catfish rarely recruit to the adult population as a result of predation by Largemouth Bass and Bluegill (Neal and Willis 2012). As a result of predation, Channel Catfish must be periodically stocked to maintain fishable populations (Neal and Willis 2012). Put-grow-take fisheries are less costly than stocking catchable catfish, but predation must be considered. Studies have shown that stocked Channel Catfish should be 250mm or greater in length to avoid predation by Largemouth Bass (Howell and Betsill 1999; Jackson and Francis 1999; Odenkirk 2002; Neal and Willis 2012). Results from the most recent Virginia Statewide Angler Survey (2016) found that 54% of Virginia anglers specifically fished for catfish in the last twelve months (VDGIF 2016 Angler Survey). Virginia anglers pursued catfish in a variety of habitats including: small impoundments (23%), large impoundments (27%), warmwater streams (38%), and private lakes (12%).

The Virginia Department of Wildlife Resources (VDWR) has been managing a variety of small impoundments throughout the Commonwealth by stocking sub-catchable and catchable Channel Catfish. Channel Catfish are obtained from commercial hatcheries at considerable cost (up to $120K/year). Many anglers pursuing Channel Catfish stated that they only fished DWR managed or owned small impoundments (27%), documenting the popularity of these intensively managed resources.

Methods

Past research has led to the development of Channel Catfish (CCF) stocking guidelines for managing DWR owned or managed small impoundments (Table 1). These rates serve as a general guide and target for stocking – fish may be stocked at lower rates when circumstances (budget, impoundment status) require.

Table 1. Channel Catfish stocking Guidelines for waters managed by DWR.

Waterbody	Stocking Rate
Standard non-DWR Impoundment	10/acre
DWR Impoundment	15/acre
DWR Impoundment w/high pressure	20/acre
CLIP Ponds	100/acre
Urban	250/acre

Stocking rates are tailored towards angling pressure, public access, and catchability. General CCF stockings utilize a fish that average about a half pound (~10”), while fish used in the Urban Fishing Program average about 1 pound. Standard impoundments are managed less intensively and stocked at lower rates than DWR owned lakes. Many of these waters may have a lower degree of angler use and in many cases more restrictive access. These standard impoundments are stocked in the fall at a rate of 10 CCF/acre (Table 2).

Table 2. Channel Catfish allocations for impoundments stocked at the standard rate (10/acre). The minimum allocation is 50 fish. Stocking Rate = SR.

Region	County	Waterbody	Size (acres)	SR (#/acre)	Allocation
1	Chesapeake	Oak Grove Lake	70	10	700
1	Hampton	Sandy Bottom Park Pond	12	10	120
2	Amherst	Mill Creek Lake	189	10	1890
2	Appomattox/Buckingham	Holliday Lake	145	10	1450
2	Brunswick	Great Creek Lake	212	10	2120
2	Buckingham	Slate River Reservoir	38	10	380
2	Buckingham	Bear Creek Lake	42	10	420
2	Buckingham	James River State Park Ponds (3)	3	10	150
2	Cumberland	Cumberland State Forest Lakes (4)	28	10	280
2	Fort Pickett	Beavertrail Pond	2.4	10	50
2	Fort Pickett	Wonju Pond	2.5	10	50
2	Fort Pickett	Dearing Pond	7	10	70
2	Fort Pickett	Butterwood Pond	9	10	90
2	Fort Pickett	Engineers Pond	12.8	10	128
2	Fort Pickett	Lewis Pond	12	10	120
2	Henry	Martinsville Reservoir	175	10	1750
2	Lunenburg	Victoria Reservoir/Lunenburg Lake	15	10	150
2	Lunenburg	Nottoway Falls Lake	60	10	600
2	Lunenburg	Modest Creek Lake	29	10	290
2	Nottoway	Fort Pickett Reservoir	384	10	3840
2	Prince Edward	Goodwin Lake	15	10	150
2	Prince Edward	Prince Edward Lake	36	10	360
2	Prince Edward	Wilcks Lake	30	10	300
3	Carroll	Lovill's Creek Lake	45	10	450
3	Dickenson	Laurel Lake	14	10	140
3	Pulaski	Gatewood Reservoir	162	10	1620
3	Smyth	Sugar Hollow Pond	1	10	50
3	Smyth	Glade Mountain Ponds (4)	8	10	200

3	Tazewell	Lincolnshire Lake	23	10	230
3	Tazewell	Witten Lake	52	10	520
3	Wise	Wise Reservoir	46	10	460
3	Wise	Big Cherry Reservoir	132	10	1320
3	Wise	North Fork Pound Reservoir	154	10	1540
3	Wise (City of Norton)	Norton Reservoir (upper)	9	10	90
3	Wythe	Wytheville C.C. Pond	3	10	50
4	Albemarle	Beaver Creek	104	10	1040
4	Albemarle	Chris Green Lake	62	10	620
4	Albemarle	Mint Springs Lake	8	10	80
4	Albemarle	Totier Creek Lake	66	10	660
4	Albemarle	Walnut Creek Lake	60	10	600
4	Alleghany	Clifton Forge Reservoir	9	10	90
4	Augusta	Elkhorn Lake	50	10	500
4	Augusta	Hearthstone Lake	14	10	140
4	Augusta	Sherando Lake (lower)	20	10	200
4	Augusta	Sherando Lake (upper)	8	10	80
4	Bath	Douthat Lake	52	10	520
4	Bath	Rec Pond Lower	32	10	320
4	Bath	Rec Pond Upper	40	10	400
4	Fairfax	Fairfax Lake	28	10	280
4	Fairfax	Huntsman Lake	27	10	270
4	Fairfax	Royal Lake	35	10	350
4	Fauquier	Germantown Lake	109	10	1090
4	Frederick	Clearbrook Lake	3	10	50
4	Louisa	Gordansville Lake	81	10	810
4	Louisa	Northeast Reservoir	187	10	1870
4	Loudon	Sleeter Lake	101	10	1010
4	Page	Arrowhead Lake	34	10	340
4	Page	Bealer's Ferry Pond	7	10	70
4	Page (Town of Shenandoah)	Big Gem Pond	1	10	50
4	Prince William	Silver Lake	23	10	230
4	Rockingham	Briery Branch Lake	9	10	90
4	Rockingham	Hone Quarry Lake	6	10	60
4	Rockingham	Silver Lake	10	10	100
4	Rockingham	Slate Lick Lake	10	10	100
4	Shenandoah	Tomahawk Pond	2	10	50
4	Shenandoah	Lake Laura	44	10	440
4	Spotsylvania	Motts Run Reservoir	160	10	1600
4	Stafford	Abel Lake	185	10	1850

DWR owned and managed impoundments are intensively managed for multiple species of fish and receive higher stocking rates than non-DWR impoundments. Most DWR impoundments offer boat access, adequate parking, night-time fishing, shoreline access, and at many locations a handicapped accessible fishing pier. DWR owned small impoundments are stocked in the fall at a rate of 15 CCF/acre (Table 3).

Table 3. Channel Catfish allocations for impoundments stocked at the DWR rate (15 fish/acre). The minimum allocation is 50 fish. Stocking Rate = SR.

Region	County	Waterbody	Size (acres)	SR (#/acre)	Allocation
2	Amelia	Amelia Lake	100	15	1500
2	Brunswick	Brunswick Lake	150	15	2250
2	Buckingham	Horsepen Lake	19	15	285
2	Halifax	Connor Lake	110	15	1650
2	Mecklenburg	Gordon Lake	157	15	2355
2	Nelson	Lake Nelson	40	15	600
2	Nottoway	Nottoway Lake	188	15	2820
3	Lee	Keokee Lake	92	15	1380
3	Washington	Hidden Valley Lake	61	15	915
3	Wythe	Rural Retreat Lake	90	15	1350
4	Albemarle	Lake Albemarle	35	15	525
4	Fairfax	Burke Lake	218	15	3270
4	Fluvanna	Fluvanna Ruritan Lake	50	15	750
4	Frederick	Frederick Lake	117	15	1755
4	Powhatan	Powhatan Lake (lower)	36	15	540
4	Powhatan	Powhatan Lake (upper)	35	15	525
4	Powhatan	Powhatan Ponds	20	15	300
4	Stafford	Curtis Lake	91	15	1365

DWR owned impoundments that receive high angling pressure are stocked in the fall at a higher rate (20 CCF/acre) than normal to provide better catch rates (Table 4). Some of the heaviest fished DWR impoundments are also fertilized to increase fish production and may offer concessions that include boat rentals, bait, and snacks.

Table 4. Channel Catfish allocations for impoundments stocked at the DWR-High Pressure rate (20 fish/acre). The minimum allocation is 50 fish. Stocking Rate = SR.

Region	County	Waterbody	Size (acres)	SR (#/acre)	Allocation
1	James City	Woodstock Pond	7.5	20	150
3	Smyth	Hungry Mother Lake	108	20	2160
4	Augusta	Braley Pond	5	20	100
4	Fauquier	Lake Brittle	77	20	1540
4	Fauquier	Phelps Pond	3	20	60
4	Orange	Lake Orange	124	20	2480
4	Rockbridge	Lake Robertson	26	20	520
4	Rockingham	Shenandoah Lake	36	20	720

Small ponds that are intensively managed that receive heavy fishing pressure in developed areas are managed under CLIP (Community Lake Improvement Program). These small ponds receive 100 CCF/acre and are stocked in the fall (Table 5).

Table 5. Channel Catfish allocations for impoundments stocked at the CLIP rate (100 fish/acre). The minimum allocation is 50 fish. Stocking Rate = SR.

Region	County	Waterbody	Size (acres)	SR (#/acre)	Allocation
1	Ashland	DeJarnette Park Lake	1	50(1/2 CLIP)	50
1	City of Petersburg	Willcox Lake	22	50(1/2 CLIP)	220
1	Hanover	Courthouse Pond	3	50(1/2 CLIP)	150
1	Henrico	Crump Park Lake	2	100	200
1	Henrico	Deep Run Park Pond - lower	2	100	200
1	Henrico	Deep Run Park Pond - upper	2	100	200
1	Henrico	Echo Lake Park	12	50(1/2 CLIP)	600
1	Henrico	Three Lake Park (Lake #1)	7	50(1/2 CLIP)	300
1	Richmond (City)	Bryan Park Lake (Youngs Pond)	6	50(1/2 CLIP)	300
1	Richmond (City)	Forest Hill Park Lake	5	3/10 CLIP	150
1	Richmond (City)	Swan Lake	23	1/4 CLIP	300
2	Franklin	Gilly's Pond	2.5	100	250
2	Franklin	Woody's Pond	2.5	100	250

4	Albemarle	Scottsville Lake	2	100	200
4	Fairfax	EC Lawrence Pond (Walney)	1	100	100
4	Fairfax	Mason Neck Pond	2	100	200
4	Fairfax	Woodglen Lake	3	100	300
4	Fauquier	Sky Meadows SP Pond	1	100	100
4	Fauquier	WARF (Warrenton)	1.5	100	150
4	Loudon	Banshee Reeks Pond	1	100	100
4	Loudon	Claude Moore Lower Pond	1	100	100
4	Loudon	Claude Moore Upper Pond	1.5	100	150
4	Loudon	Franklin Park Pond	1	100	100
4	Prince William	Merrimac Farm Pond	1	100	100
4	Spotsylvania	Anna State Park Pond	1	100	100

Virginia's Urban Fishing Program began in the 1990's and includes both a winter trout stocking program in addition to a late spring CCF stocking program. This program has functioned with a goal of providing anglers a catch rate of 1 fish/hour. These urban waters were developed with the hope of recruiting new anglers in the more developed areas of Virginia. Most of the urban sites are located in county or municipal parks that offer ample parking, restroom facilities, and other amenities that are family friendly. Urban waters are stocked in the spring with CCF averaging one pound at a rate of 250/acre (Table 6).

Table 6. Channel Catfish allocations for impoundments stocked at the Urban rate (250 fish/acre). The minimum allocation is 50 fish. Channel Catfish are stocked during the spring. Stocking Rate = SR.

Region	County	Waterbody	Size (acres)	SR (#/acre)	Allocation
1	Chesapeake	Northwest River Park	3	250	425
1	City of Hampton	Lake Armisted	3	250	1000
1	Henrico	Dorey Park Pond	5	250	1750
1	Richmond (City)	Shields Lake	7	250	1750
2	City of Lynchburg	Clemmons Lake	1.4	250	350
4	Alexandria	Cook Lake	4	250	1000
4	Prince William	Locust Shade	8	250	2000
4	City of Fredericksburg	Old Cossey Pond	3	250	750

Regulations

Channel Catfish regulations for small impoundments fall under three categories that vary from the standard statewide regulation of 20 per day with no length limit. Costs associated with purchasing and stocking catchable size catfish have necessitated a more restrictive set of regulations that creates more of a put-grow-take program versus put and take with the exception of the urban sites. Urban sites are managed with a 4 fish/day regulation with no minimum length that allows for immediate harvest. Biologists may opt to manage the other stocked waters under either a 5 fish/day 15 inch minimum length or 5 fish/day 18 inch minimum length. These regulations are in place to allow for at least a year's growth prior to legal harvest after stocking.

Program Effectiveness

Any program should be evaluated for effectiveness, particularly a program that is a large budget item. Channel Catfish stockings have been periodically evaluated at sites around the Commonwealth to look at fishing pressure, catch rates, harvest, and angler satisfaction. Angler surveys are the easiest and most cost effective means to evaluate success of a Channel Catfish stocking program in terms of angler success, angler recruitment/retention, and program popularity. Past surveys have evaluated the Channel Catfish stockings at our Urban Fishing Sites as well as many of our DWR impoundments (i.e. Lake Orange). Channel Catfish tend to rank as the second to third most popular fish species at many of our public fishing lakes. Channel Catfish also tend to provide for the highest harvests by anglers at many of our sites. As an example, Lake Orange has had an annual creel survey for over 20 years offering the best small impoundment data set in Virginia. In 2020, Channel Catfish were the second most abundant species harvested by anglers (N = 1009; WT = 1073 kg; Mean WT = 1.1 kg). It is important to note that Lake Orange only receives an annual stocking of 2,480 Channel Catfish, while anglers are harvesting over 1,000 fish per year out of this put-grow-take fishery. This resource is highly utilized by anglers and the cost effectiveness of the program is clearly evident. Additional waters around the Virginia need to be evaluated as funding and staff time allows.

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