Indiana
Muskellunge Strategic Plan
2017-2022

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Cover photo: Division of Fish and Wildlife seasonal aide Josh Turner holds a Muskie collected from Webster Lake (Kosciusko Co.) during broodstock collections in April 2016.

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MANAGEMENT HISTORY

Muskellunge (*Esox masquinongy*; hereafter referred to as Muskies) are native to Canada and the United States including the Great Lakes, upper Mississippi River and Ohio River drainages. Muskies were native to Indiana's tributary rivers connected to the Ohio River, but habitat changes nearly eliminated all natural populations. Efforts to re-establish Muskies began in 1974[1]. Today thirteen Muskie populations in Indiana are maintained by stocking hatchery raised fish.

Muskies are some of the largest fish in Indiana and anglers usually release the Muskies they catch, prizing them more for their trophy-size and challenge to catch rather than edibility. Although growth of older male Muskies is slow and few ever reach 44 inches, females typically reach 36 inches at age-7 and 44 inches at age-12. Under the right conditions, female Muskies can grow longer than 50 inches, weigh over 40 pounds, and live more than 20 years. The Indiana state record was caught in 2002 at James Lake (Kosciusko Co.) and weighed 42 pounds, 8 ounces.

Muskies are one of several predator fish produced by the hatchery staff within the Division of Fish and Wildlife (DFW) to diversify fishing opportunities throughout the state. These stockings expand angler choices beyond the scope of naturally reproducing populations by utilizing habitats and forage without negative impacts on other species. Today, the DFW stocks Muskies to provide trophy fishing opportunities and use available forage, especially where abundant fish such as Gizzard Shad (*Dorosoma cepedianum*) or suckers (family Catostomidae) are present. Early attempts to use Muskies as a predator management tool to control over-abundant panfish were unsuccessful at two glacial lakes[2].

Muskies are considered a coolwater species and thrive best at 68-73°F temperatures and oxygen levels ≥3 ppm. As a sight-feeder they prefer clear water and ambush cover in dense vegetation or wood structure. Optimum conditions include stable water levels. Although habitat conditions appear favorable for spawning in many lakes, Ball Lake (Steuben Co.) is the only lake where natural Muskie reproduction has been noted (DFW 2013)[3].

Initial Muskie stockings were made at Brookville Reservoir (Franklin/Union Co.). Out-of-state sources for eggs, fry, and fingerlings were initially used to expand the program. Muskies stocked in the 1970-80s were mostly hybrid crosses with Northern Pike (Tiger Muskies) that were less than 6 inches long and mainly reared on pelleted food. They were typically stocked at 5-8/acre in hopes that 20% would survive to adulthood[4]. Survival was poor however, due to their small size and inability to avoid other predators[5]. As a result, hybrid stockings were phased out in favor of larger purebred Muskies (8-10 in) fed pellets initially but also fed minnows prior to release. By 1997 an in-state hatchery brood source was established at Webster Lake (Kosciusko Co.) based on various out-of-state original sources (IL, IA, OH, PA, and WI). Eventually some purebred stockings were

[1] James. W. D. 1974. Muskellunge: literature review, feasibility notes. Indiana Division of Fish and Wildlife.
[2] Pearson, J. 2005. Impacts of predator management on Bluegill fishing at Loon Lake. Indiana Division of Fish and Wildlife. 30pp.
[3] DFW. 2013. Muskies reproducing in Ball Lake. News release. Indiana Division of Fish and Wildlife.
[4] Andrews, S.J. 1983. Survival and growth of tiger muskellunge reared on live versus artificial diets. Indiana Division of Fish and Wildlife. 37pp.
[5] Andrews, S.J. 1982. Tiger muskellunge survival and habitat utilization in three northeast Indiana lakes. Indiana Division of Fish and Wildlife. 19pp.

also discontinued where Muskie survival was poor or angler-use low. Survival of stocked fingerlings has also declined recently at Lake Webster[6]. As a result, a study is also now underway there to compare survival of Muskies typically stocked in the fall versus Muskies stocked the following spring when they are larger, submersed plant cover is expanding, and more natural food becomes available.

As Indiana's Muskie program improved, fishing regulations also evolved. A 30-inch minimum size limit was established in 1975 and increased to 36 inches in 1998. In 2015, a special 44-inch limit was imposed at Webster Lake at the request of Muskie anglers but also in part to protect female broodfish. The daily harvest limit is 1 Muskie per day was also established in 1975. Today's Muskie regulations in Indiana (312 IAC 9-7-4) are similar to Illinois, more restrictive than Ohio and Kentucky, but generally less restrictive than other Midwest states.

POPULATION STATUS

The DFW currently stocks about 21,000 age-0 Muskies typically measuring 8 inches (South Region) to 10 inches long (North Region) each fall at rates varying from 1-5/acre in 13 waters totaling 10,524 acres (Table 1). The typical rate is 5/acre and is based on the original assumption of 20% annual mortality. Although higher than stocking rates used by other states, the intent is to optimize Muskie densities, sizes, angler interest, and angler catches at a few selected waters in lieu of providing low-density populations over many waters. Indiana Muskie waters include six glacial lakes (3,170 ac), two impoundments (6,610 ac), and five excavated lakes (744 ac). Two glacial lakes totaling 308 acres are also stocked by local anglers with Muskies purchased from a commercial hatchery, although one (Loon; Noble/Whitley Co.) was previously stocked by the DFW. Muskies stocked by the DFW are reared at the East Fork Hatchery with eggs obtained from broodstock collected each spring at Lake Webster (Kosciusko Co.). Fry and small fingerlings are fed dry pellets through August and then minnows for 30-45 days. Production costs (direct, supplemental and administrative) are about $120,000/year. The previous capture quota for broodstock was 25 mature females needed to supply 1.5 million fertilized eggs (500,000 streaked eggs shipped to East Fork). Due to improvements in egg handling techniques (e.g., use of TRIS as a buffering agent) and hatchery efficiency, the quota was reduced to 500,000 eggs (250,000-300,000 streaked eggs) in 2016 and will likely be reduced even further. The egg-taking operation usually requires 40-50 trap lifts and was supplemented in 2016 with additional females captured in nearby James Lake of the Tippecanoe chain (Kosciusko Co.). Also beginning in 2016, the stocking rate at Lake Webster was adjusted to 2/acre of fall age-0 Muskies and 2/acre of spring age-1 Muskies. These spring-stocked fish were held overwinter at the Fawn River Hatchery.

Summer gill net catches of 1-2 adult Muskies/lift have been common (median 0.9; interquartile range 0.4-2.1) where Muskies are stocked but spring trapping is the preferred sampling method. Electrofishing for juvenile or adult Muskies proved ineffective[7]. Current sampling guidelines require a minimum of eight trap net lifts in March or April at three or more locations using either large Lake Michigan (LM-style) or small Inland Michigan (IM-style) traps. Site location, trap style, Muskie total length, and gender are reported for each sample. Muskie ages based on pectoral

[6] Pearson, J. 2015. Decline of the muskellunge population and fishery at Lake Webster. Indiana Division of Fish and Wildlife. 42pp.
[7] Pearson, J. 2005. Juvenile Muskellunge electrofishing assessments. Indiana Division of Fish and Wildlife. 8pp.

fin ray samples have been reported in some cases but more reliable growth data is obtained from PIT-tagged (passive integrated transponder) fish.

The trap net catch rate of Muskies at 14 waters since 2004 (Table 2) ranged from 0-20.7/lift and provided a median catch rate of 1.1/lift (interquartile range: 0.4-4.3/lift), although none were caught at Bluegrass Pit (Warrick Co.) in 2017, or West Lake (Sullivan Co.) and Waveland Lake (Montgomery Co.) in 2013. Stockings at West and Waveland have been discontinued due to poor results. DFW stockings at Loon Lake (Noble/Whitley Co.) were also discontinued due to the low catch rate, low interest, and failure to improve bluegill fishing. Trap catch rates are generally higher at glacial lakes and impoundments than excavated lakes, due in part to the difficulty in finding suitable trapping sites in steep-sided excavated lakes. Muskies less than stock-size (< 20 in) are not vulnerable to traps. Those that are stock-size (20-30 in) are not especially vulnerable either but are caught on occasion (< 3% of the cumulative catches). Quality-size Muskies (30-38 in) account for the largest proportion (66%) of all stock-size and larger Muskies. The median number of quality-size Muskies captured during spring trapping (standardized to eight lifts) is 3 (inter-quartile range: 1-28). Preferred-size Muskies (38-42 in) make up 20% of the catch and provide a median catch of 1 Muskie (interquartile range: 0-6). Memorable-size Muskies (42-50 in) account for 11% of the cumulative catch and are caught at a median catch rate of 1 Muskie (inter-quartile range: 0-3). During the 14 sampling occasions since 2004, no trophy-size Muskies (≥ 50 in) were caught, but two have been captured at Webster Lake during broodstock operations. Where sex ratios have been documented, the split between males (52%) and females (48%) is about equal, although females are typically larger and older.

Table 1. Summary details of currently stocked Muskie waters in Indiana.

Waterbody	County	Resource Type	Acres	N/Acre	N stocked[1]	Initial Year	Regulation
Barbee Lakes Chain	Kosciusko	Glacial Lake	850	5	4250	1998	Standard
Bass	Sullivan	Excavated Lake	222	5	1110	1997	Standard
Bluegrass	Warrick	Excavated Lake	195	5	975	2006	Standard
Brookville	Franklin/Union	Impoundment	5260	1	5260	1974	Standard
Bruce	Pulaski	Glacial Lake	245	5	1225	2000	Standard
Duck	Sullivan	Excavated Lake	59	5	295	2008	Standard
Eagle Creek	Marion	Impoundment	1350	1	1350	2011	Standard
Everett	Allen	Glacial Lake	43	5	215	2010	Standard
Loon Pit	Warrick	Excavated Lake	184	5	920	2006	Standard
Plover/Sandpiper	Bartholomew	Excavated Lake	84	5	500	1997	Standard
Skinner	Noble	Glacial Lake	125	5	625	1986	Standard
Tippecanoe Chain	Kosciusko	Glacial Lake	1133	1	1133	1997	Standard
Webster[2]	Kosciusko	Glacial Lake	774	4	3096	1981	44-inch
DFW Subtotal	-	-	**10,524**	-	**20,954**	-	-
Loon[3]	Noble/Whitley	Glacial Lake	222	1	200	1978	Standard
Upper Long[3]	Noble	Glacial Lake	86	2	172	1996	Standard
Statewide Total	-	-	**10,832**		**21,326**		

[1] Current stocking rate.
[2] 50:50 ratio of fall age-0 and spring age-1 fingerlings.
[3] DFW-permitted private stockings.

Table 2. Targeted Muskie CPUE (N/lift) by size class based on a random sample of waters surveyed with trap nets since 2004.

Lake	County	Resource Type	Year	CPUE	N (Standardized to 8 trap net lifts)					
					<Stock (< 20)	Stock (20-30)	Quality (30-38)	Preferred (38-42)	Memorable (42-50)	Trophy (50+)
Loon	Noble	Glacial Lake	2004	1.0	0	0	7	1	0	0
Webster	Kosciusko	Glacial Lake	2006	7.3	0	8	42	6	3	0
Ball	Steuben	Glacial Lake	2008	2.3	0	2	14	0	2	0
Bass	Sullivan	Excavated Lake	2008	20.7	0	0	112	37	16	0
Skinner	Noble	Glacial Lake	2008	5.0	0	0	34	6	0	0
Bruce	Pulaski	Glacial Lake	2012	6.7	0	0	32	12	10	0
Waveland	Montgomery	Impoundment	2013	0.0	0	0	0	0	0	0
West	Sullivan	Excavated Lake	2013	0.0	0	0	0	0	0	0
Big Barbee/Kuhn	Kosciusko	Glacial Lake	2015	1.1	0	0	1	5	3	0
Duck	Sullivan	Excavated Lake	2016	0.3	0	0	2	0	0	0
James	Kosciusko	Glacial Lake	2016	2.0	0	0	2	8	6	0
Plover/Sandpiper	Bartholomew	Excavated Lake	2016	0.9	0	0	3	1	3	0
Bluegrass	Warrick	Excavated Lake	2017	0.0	0	0	0	0	0	0
Loon Pit	Warrick	Excavated Lake	2017	0.7	0	1	3	1	0	0
			1st Quartile	0.4	0	0	1	0	0	0
			Median	1.1	0	0	3	1	1	0
			3rd Quartile	4.3	0	0	28	6	3	0

ANGLER STATUS

Muskies ranked 17th among sport fish sought by anglers in 2016[8], stimulate $4.1 million annually in statewide economic activity and generate nearly $300,000 in general fund tax revenue. Although just 1.5% of anglers in general fish for Muskies, where they have been stocked the median percentage of anglers who seek them has been 13% (interquartile range: 6-23) and as high as 61% at Lake Webster. The median number of hours required to catch a Muskie is 17 (interquartile range: 11-19). Very little harvest occurs due to a strong catch-and-release ethic among Muskie anglers. At Lake Webster in 2005 anglers harvested only 14 Muskies but caught and released 2200. At Bass Lake in 2008 anglers harvested no Muskies but caught and released 83. Where Muskie anglers have been asked, 60% typically describe fishing as good (interquartile range: 55-75%). Only 5% consider it poor (interquartile range: 5-12).

Only 40 Muskies have been entered in Indiana's Record Fish or Fish of the Year programs since 1963, including 20 since 2000. Thirteen were memorable size (42-50 inches) and seven were trophy-size (50+ inches). Five were entered in 2009 but only three since 2010. Of the 20 Muskies reported since 2000, 17 were caught in seven glacial lakes, two were caught in an impoundment (Hardy Lake, Scott Co.), and one was caught in the Tippecanoe River (White Co.). Sixteen hybrids (i.e., Tiger Muskie) were registered between 1979 and 2004.

[8] Responsive Management. 2017. Indiana anglers' fishing participation and their opinions on fishing management issues. Responsive Management National Office. 228 pp.

Indiana Muskie fishing also supports fishing guide businesses, primarily in northeast Indiana[9]. Guided Muskie trips at seven glacial lakes increased to a peak of 505 in 2008 but declined to only 123 by 2016. The median number of trips from 2000-2016 was 210 (interquartile range: 112-346). Nine trips in 2012 and two trips in 2016 were reportedly guided on the St. Joseph River near South Bend. Muskie catches by guided clients also decreased from 357 in 2008 to 141 in 2016 (interquartile range: 142-292). Sixteen guides reported activity in 2008 but the number dropped to six by 2016. Based on a 2013 poll, five out of 10 guides who responded said fishing was declining, although four continued to rate it as good, two considered it excellent, three described it as fair, and one said Muskie fishing was very poor.

Table 3. Angler preference for Muskies, Muskie fishing effort, and Muskie catch rates based on a random sample of waters where creel surveys have been conducted since 2005.

Water	Year	Preference Percentage[2]	Muskie Hours/100acre/day[3]	Hours/ Muskie[4]
Loon	2004	12	3.8	14.8
Webster[1]	2005	61	21.4	18.4
Ball	2008	17	3.3	89.1
Bass	2008	13	1.4	10.5
Skinner	2008	26	5.6	17.1
Upper Long	2010	34	15.3	10.2
Waveland	2013	0.1	0.0	-
Bruce	2014	18	1.7	47.7
Big Barbee	2015	10	2.3	-
Bluegrass	2016	0.1	0.0	0.9
Loon Pit	2016	1	0.2	18.7
1st Quartile		5.5	0.8	10.5
Median		13	2.3	17.1
3rd Quartile		22	4.7	18.7

[1] Boat anglers only.

[2] Muskies mentioned alone or in combination of all respondents and not individuals.

[3] Multiplying the estimated angler hours for the entire creel survey times the preference for Muskies divided by the total number of days covered in the creel survey divided by the acres and multiplied by 100 to get values with only one decimal.

[4] The estimated Muskie hours divided by the total catch (harvest and releases).

PROGRAM ANALYSIS

The DFW continues to receive stable support from the estimated 3,291 anglers who are uniquely interested in Muskie fishing. In 2016, the DFW spent approximately $175,000 raising and managing Muskie. Meanwhile, the license sale revenue generated for the DFW based on the number of Muskie anglers was approximately $34,000. Thus, the supply:demand ratio (i.e., expense:revenue ratio) of the Muskie program is 5.2:1; greater than the 2.5:1 cool-water target

[9] Pearson, J. 2013. A summary of fishing effort, catch, and opinions reported by Indiana Muskie guides. Indiana Division of Fish and Wildlife. 12pp.

established by the DFW to create diverse sport fishing opportunities. Because existing Muskie fishing opportunities are exceeding current demand, expansion of the Muskie program is not warranted at this time. The DFW should maintain current production levels but focus management efforts on ways to improve cost efficiency and reduce overall costs, while pointedly marketing Muskie fishing opportunities to recruit, retain or reactivate 6,845 Muskie anglers by 2027 and achieve the 2.5:1 cool-water supply:demand target.

The immediate priority of the Muskie program is to maintain an adequate, pathogen-free and genetically-diverse, large-female dominated broodstock population (due to the lack of natural reproduction) and the hatchery infrastructure (i.e., egg-taking station, equipment, pond space, water quality, forage, biosecurity, predator control, and personnel) capable of sustaining the current production of 21,000 fingerlings. A secondary broodstock population or alternative egg source may also be required to address egg-taking shortfalls and potential problems at Lake Webster. If future sampling results show stocking fewer but larger age-0 (fall stocking) or age-1 (spring stocking) Muskies provide a better return on investment while maintaining dense populations with high angler catch rates and satisfaction, some reductions in stocking rates and adjustments in hatchery needs (i.e., over-wintering capacity) will be pursued. Meanwhile there is little evidence to suggest high stocking rates, while more costly to maintain, are preventing the development of greater Muskie densities where catches are low. As a result, more work is needed to identify waters that fail to meet Muskie population standards based on trap-nets and creel surveys in order to allocate stockings to locations with appropriate levels of success. However, some reductions in stocking rates may be incorporated where sampling indicates Muskies are negatively impacting fishing for other species.

Another priority of the Muskie program is to recruit, retain or reactivate more Muskie anglers to offset costs. Effective marketing of the program begins with choosing optimum locations for stocking and establishing fishable Muskie populations. Once established, the DFW should target marketing campaigns at Muskie waters that have low interest and use. Waters where local conditions prevent development of fishable populations, are difficult to assess, or fail to generate sufficient angler interest following marketing efforts should be deleted from the program. Stockings should then be reduced or re-allocated to potentially better sites.

Current regulations are adequate to protect Muskies given the growth limits of males and a well-established catch-and-release ethic. Some opportunities may exist to shift production of Muskies to more females with a larger growth potential. Other opportunities to improve the Muskie program include: better understanding of optimum stocking strategies (i.e., numbers and sizes); geographically distributing stockings that are currently clustered in northeast and southwest corners of the state; identifying and addressing habitat conditions that limit or threaten stocking and fishing success (i.e., loss or lack of a coolwater layer, poor water clarity, high flushing rates, declining vegetation, and disappearing woody cover) and evaluating whether Muskies pose risks to other species. Basic research that can shed light on the factors that limit natural reproduction, maximize the survival of stocked age-0 or age-1 fish, or generate more interest in Muskie fishing is needed.

STRATEGIC PLAN

Population Goal: Ensure high quality Muskie fisheries that are geographically dispersed.

Objective: Maintain annual broodstock collection that yields 500,000 fertilized eggs.

- **Problem:** Relying on a single broodstock source (Lake Webster) poses a shortfall risk (i.e., capturing enough gravid females) and creates potential disease, growth, and genetic issues.
- **Strategies:**
    1. Develop a back-up broodstock source and use best management practices to address potential disease, growth, and genetic issues.
    2. Adjust stocking strategies (e.g., timing, rate) and regulations (e.g., size, location, season) to sustain an adequate population of adult broodstock.
    3. Examine broodstock operations, including the possibility of reducing the number of required eggs, to improve cost efficiency.
    4. Explore options to obtain eggs, milt, fry or fingerlings from other state or commercial sources.
    5. Develop and incorporate a sound broodstock collection, spawning and fish stocking plan to maintain genetic integrity.

Objective: Sustain current hatchery production of 19,500 fall age-0 Muskie fingerlings ≥ 10 inches to annually stock defined Muskie waters and 1,500 spring age-1 fingerlings ≥ 12 inches for Lake Webster.

- **Problem:** Hatchery labor, utility, and forage requirements for Muskie fingerling production are expensive.
- **Strategies:**
    6. Evaluate production process to improve efficiency and security.
    7. Investigate cost-effectiveness of commercial purchases of Muskie fingerlings and forage.
    8. Seek additional funding sources and partner with Muskie anglers to supplement costs.
- **Problem:** Potential shortfalls in numbers and sizes may occur during the fingerling production process up to and including the time of stocking.
- **Strategies:**
    9. Maintain contacts with other states and commercial sources for any potential emergency needs.
    10. Develop a priority process for allocating fingerlings based on available numbers and sizes.

Objective: Create adult Muskie populations at all stocked waters such that 8 spring trap-lifts produce a minimum catch of 5 Muskies within 8 years of initial stocking and at least one of preferred (≥ 38 inches) and one of memorable (≥ 42 inches) size within 10 years of initial stocking.

- **Problem:** Spring trap-netting may not be suitable to adequately evaluate Muskie populations at some waters.
- **Strategies:**
    11. Rely on measures of angler interest and catches to verify fishable Muskie populations exist where trap-net results are questionable (e.g., excavated lakes with few shallow-water areas: see Human Dimension objectives and strategies).
    12. Only stock new waters that are most readily evaluated by trap-nets.
    13. Conduct an assessment of adult populations within 8 years of initial stocking and repeat sampling by year 10 if initial results are inconclusive.
- **Problem:** Water-specific factors may prevent achieving Muskie population success criteria.
- **Strategies:**
    14. Stock optimum waters where emigration, potential habitat and forage limitations, or competition with other fish are least likely to affect Muskie abundance and size.
    15. Adjust stocking strategies where predation, cannibalism, and intra-specific competition may impact survival and growth.
    16. Conduct periodic trap-net assessments at all Muskie waters to confirm success criteria are met and re-allocate stockings to alternative locations where limiting factors cannot be minimized.
- **Problem:** Sex-specific factors may prevent achieving Muskie population size criteria.
- **Strategy:**
    17. Examine the feasibility of shifting to female-only stockings to increase Muskie growth and maximum length.

<u>Human Dimensions Goal: Promote sufficient numbers and types of waters capable of attracting and sustaining adequate angler interest and satisfaction with Muskie fishing.</u>

Objective: Increase the number of Muskie anglers by 54% from 3,291 (2017) to 5,068 (2022).

- **Problem:** Angler motivational barriers that limit interest in Muskie fishing are not known.
- **Strategies:**
    18. Identify potential limiting factors from responses in the Licensed Angler Survey.
    19. Conduct targeted surveys of Muskie anglers and non-Muskie anglers selected from point-of-sale license buyers (e.g., Qualtrics) to understand barriers.
    20. Determine whether local barriers exist (e.g., lake size, amenities, boating restrictions) that reduce interest and use of Muskie fishing opportunities.
    21. Understand and address anti-Muskie sentiment and misconceptions that may limit interest and support for Muskie stockings and Muskie fishing.
- **Problem:** Insufficient marketing of regional and local Muskie fishing opportunities limits the potential number of Muskie anglers.
- **Strategies:**
    22. Work with partners (e.g., Muskie anglers, guides, tournament organizers, lake residents, local communities) to promote (e.g., through Go FishIN program)

Muskie fishing to overcome barriers (e.g., perceptions) that block interest and participation.

23. Use traditional (e.g., television, print, sport shows, signs) and social media (e,g., email, websites, message boards, Facebook) to promote Muskie fishing.
24. Increase awareness, interest, and participation in Muskie fishing through the Record Fish and Fish-of-the-Year Program.

- **Problem:** Ineffective marketing methods limits the potential number of Muskie anglers.
- **Strategies:**
    25. Evaluate on-going promotional techniques and programs to identify and expand successful Muskie fishing marketing efforts.
    26. Investigate and incorporate effective alternative Muskie marketing programs.

Objective: Ensure Muskie fishing effort is at least 13% of boat-anglers and the catch rate is at least one Muskie per 17 hours of Muskie fishing at all waters stocked with Muskies.

- **Problem:** Lack of inexpensive and standardized creel survey methods limits evaluation of Muskie angler preference, effort, catch, and satisfaction.
- **Strategies:**
    27. Develop and conduct standardized, targeted, low-cost creel surveys initially within 8 years at newly-stocked waters and periodically at all stocked waters.
    28. Use Muskie guide reports and investigate the feasibility of alternative approaches (e.g., tournament results, diaries, contact cards) to collect supplemental creel data.
    29. Refine analysis of past creel surveys to match future targeted surveys to improve standard metrics for Muskie preference, effort, catch, and satisfaction.
- **Problem:** Attracting sufficient interest in Muskie fishing may be difficult at waters where high-quality, high-use fisheries exist for other species.
- **Strategies:**
    30. Develop partnerships with Muskie anglers to encourage and enable non-Muskie anglers to experience Muskie fishing.
    31. Determine if alternative waters may be better suited for Muskie stockings to generate sufficient Muskie fishing interest and effort.

Habitat Goal: Sustain quality Muskie habitat where present and improve Muskie habitat where possible.

Objective: Where present at waters stocked with Muskies, sustain a cool-water layer (i.e., ≥1 foot thick with ≤73°F temperature and ≥3 ppm oxygen) throughout the summer and maintain sufficient structural cover (i.e., aquatic plants, woody material) for Muskies.

- **Problem:** Information on the presence and persistence of a cool-water layer and the availability of cover is not available or widely-known at all Muskie waters.
- **Strategies:**
    32. Identify Muskie waters where a cool-water layer is present based on standardized sampling of temperature and oxygen during late summer.
    33. Quantify aquatic plant coverage and biomass using a standard rake-toss sampling procedure and hydro-acoustic technology at all Muskie waters.

34. Develop and adopt a technique capable of providing information on the extent and availability of woody material where aquatic plant coverage is limited.
35. Establish standards by which habitat suitability for Muskies can be assessed at various Muskie waters.
36. Make available the information on temperature, oxygen, and habitat structure at Muskies waters to anglers, partners, and the public.

- **Problem:** Various watershed management practices can lead to excessive nutrient, sediment, and contaminant runoff that damages water quality and threatens existing Muskie habitat.
- **Strategies:**
    37. Work with partners to promote best management practices through the Lake and River Enhancement Program, soil and water conservation agencies, watershed groups, and other non-governmental organizations.
    38. Work with partners to ensure compliance with permit requirements to protect Muskie habitat.
- **Problem:** Various in-lake management practices can damage structural habitat and reduce Muskie cover.
- **Strategies:**
    39. Work with lake residents and other partners to maintain sufficient aquatic plant coverage and biomass suitable for Muskie habitat.
    40. Work with lake residents and lake managers to maintain woody material where present in Muskie waters.
    41. Encourage lake residents and partners to establish ecozones (i.e., limited boat areas) where boating activity threatens Muskie habitat.
- **Problem:** Lack of interest and support for measures to protect habitat may impact Muskie populations and Muskie fishing.
- **Strategies:**
    42. Promote the importance of habitat where actions threaten Muskie populations.
    43. Develop cooperative relationships between lake residents, managers, and Muskie anglers to foster habitat protection.
    44. Consider alternative Muskie stocking locations where excessive habitat degradation occurs and the quality of fishing opportunities decline.

Objective: Where possible at waters stocked with Muskies, develop or enhance a cool-water layer and increase structural habitat coverage in the littoral zone in at least one glacial lake and excavated lake or impoundment.

- **Problem:** Lack of awareness, interest, and financial support for Muskies may limit opportunities to enhance Muskie habitat.
- **Strategies:**
    45. Ensure consideration of potential Muskie habitat improvements with other partners involved in habitat management (e.g., Statewide Wildlife Action Plan).
    46. Identify and encourage lake associations at Muskie waters who may be interested in reducing aquatic plant control to improve overall water quality and fish habitat.

47. Work with partners with various funding sources (e.g., Lake and River Enhancement Program) to re-establish aquatic plant beds and ecozones.
48. Encourage partners to help organize and fund efforts to install woody material in Muskie waters that also benefit a variety of fish species.
49. Investigate Muskie waters as possible candidates for innovative habitat projects (e.g., aeration).

Fisheries Management

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Doug Keller — Date
Aquatic Habitat Program Manager

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Brian Schoenung — Date
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PROGRAM ACTIONS (2015-present[10])

2015

- **Strategy 2**: An experimental 44-inch minimum Muskie size limit was enacted at Lake Webster, backwater and nearby Kaiser Lake to protect more females.

- **Strategy 3**: Use of TRIS (hydroxymethylaminomethane) as a buffering agent became standard practice and increased Muskie egg fertilization/development and lowered the required number of eggs to meet production needs.

- **Strategy 5**: East Fork began Otohime diet study to improve growth. Although more expensive, Muskie fingerlings survived better and grew faster.

- **Strategy 6:** Stocked 14,839 fingerlings in 13 waters and 42,669 surplus Muskies at Brookville in 2015 and issued permits for two private stockings.

- **Strategy 8**: Minnow expenses were offset with funds donated by the Hoosier Muskie Hunters.

- **Strategy 15**: The minnow forage-finishing period for age-0 fingerlings stocked at Lake Webster was increased to boost Muskie survival and additional fingerlings were held over winter for the first time to stock larger age-1 fingerlings the following spring. The stocking strategy was adjusted to reflect 2/acre of fall age-0 fingerlings and 2/acre of spring age-1 fingerlings.

- **Strategy 16**: Muskie population status at Lake Webster was re-examined and compared to results in 2005. Spring trapping was also conducted at Barbee, Bluegrass and Loon Pit. Additional small IM-traps were purchased for Muskie work.

- **Strategy 27**: An initial Muskie creel survey at two Barbee lakes (Big Barbee and Kuhn) and a follow-up survey at Upper Long Lake were conducted using the glacial lakes status and trends survey design. A full creel survey was also conducted at Lake Webster.

- **Strategy 32**: A cool-water habitat layer was documented in August at Sechrist Lake (one of the Barbee Lakes), while Upper Long (Noble Co.) lacked a cool-water habitat layer.

- **Strategy 39**: Limits on chemical control of Eurasian milfoil were maintained at Lake Webster to increase plant coverage following a lake-wide fluridone treatment in 2010.

[10] Actions that address strategies in 2018 are listed according to priorities set in 2018.

2016

- **Strategy 1**: Gravid females were captured at James Lake to supplement egg collection at Lake Webster but poses a similar risk of potential disease issues (e.g., VHS) because it is located immediately downstream of Lake Webster. VHS testing continued at Webster.

- **Strategy 6:** Stocked 14 waters with 53,414 Muskies, including 38,058 into Brookville in 2016 and issued permits for two private stockings. Brookville stockings were upgraded to a production level rather than surplus-only stockings.

- **Strategy 14**: A fish community survey was finished at Lake Webster to address potential complaints about fishing quality for other species.

- **Strategy 15**: The first spring stocking of age-1 PIT-tagged Muskie fingerlings was made at Lake Webster.

- **Strategy 16**: Spring Muskie trapping was done at Skinner, Bass, Duck, and Plover/Sandpiper lakes.

- **Strategy 16:** A statewide Muskie dataset was compiled to organize and track Muskie data collection and analysis.

- **Strategy 27**: Full creel surveys were conducted at Bluegrass and Loon Pit.

- **Strategy 32**: A check on temperature and oxygen at Lake Webster in 2015 and 2016 indicated no cool-water layer was present.

- **Strategy 36:** Provided information on aquatic plant coverage and biomass to the Lake Webster Association during the annual Lake and River Enhancement Program coordination meeting.

- **Strategy 39:** Increased use of 2,4D to treat Eurasian water milfoil at Lake Webster was permitted in response to recovery of the plant community in 2015.

2017

- **Strategy 5:** The Natural Resources Commission de-listed the Ohio River Muskie as a genetically unique, true-reproducing, sub-species in Indiana.

- **Strategy 6:** Ten waters were stocked with 5,657 fall age-0 Muskies at reduced rates (2/acre) due to a shortage in production attributed to excessive cormorant predation. Three waters (Brookville, Eagle Creek, and Tippecanoe) were not stocked. Permits were issued for two private stockings (Loon and Upper Long lakes) totaling 600 Muskies.

- **Strategy 15**: The second stocking of 1,498 spring age-1 PIT-tagged Muskies was made. More young Muskies, including some PIT-tagged age-2 Muskies, showed up in spring trapping and angler reports.

- **Strategy 16**: Spring trapping was conducted at Bluegrass and Loon Pit.

- **Strategy 22:** Muskie program updates during 2015 through 2017 were provided to the Hoosier Muskie Hunters and to the Indiana Muskie Alliance in 2016.

- **Strategy 22:** A newsletter was produced by Bruce Lake anglers to educate anglers on the importance and availability of Muskies.

- **Strategy 23:** Several radio interviews dealing with Muskies were aired on the Indiana Outdoors radio program during 2015 through 2017 and FishIN Buddies, Inc published an interview with the district biologist on the Muskie Program at Bruce Lake in 2017.

- **Strategy 27**: A full creel survey was conducted at Bass and Duck lakes and news release promoting the creel survey was posted in May 2017.

- **Strategy 28:** Muskie guide reports for 2015 and 2016 were compiled and added to the statewide Muskie dataset. Data from 2014 reports have yet to be added. Results of the annual Indiana Muskie Classic Tournament were also compiled and included in a management update.

- **Strategy 32**: A coolwater layer was detected in the James basin but not in the Oswego or Tippecanoe basins in Lake Tippecanoe.

- **Strategy 33:** Rake-toss plant surveys and acoustic sampling was conducted at the three basins (James, Oswego, and Tippecanoe) in Lake Tippecanoe and again at Lake Webster. Plant surveys were conducted at Bass and Duck lakes and Loon Pit was mapped.

- **Strategy 43:** A moratorium on aquatic plant control was adopted for one week prior to the annual Indiana Muskie Classic tournament during 2015 through 2017 at Barbee, Tippecanoe and Webster lakes to balance interests of lake residents and tournament organizers.

- **Strategy 43**: A presentation was given to the Upper Lakes of the Tippecanoe River Association and The Watershed Foundation (includes Barbee, Loon, Tippecanoe, and Webster) to encourage volunteer monitoring of plant coverage using hydro-acoustic technology.

2018

- **Priority 1 - Strategy 32:** Muskie habitat assessments were conducted at eight stocked waters in 2018, including all seven basins within the Barbee Lakes, the main basin of Lake Tippecanoe, Bruce, Everett, and Webster lakes, as well as Bluegrass, Loon and Plover pits. To date late-summer temperature/oxygen profiles are now available at all stocked waters except Brookville and Eagle Creek reservoirs. Seven of 21 basins (33%) have no cool-water habitat. The largest cool-water layers (≥2 feet) were present in five Barbee basins and the James basin in Tippecanoe. Other stocked waters have on occasion in previous years supported cool-water habitat.

- **Priority 2 - Strategy 7:** No actions reported.

- **Priority 3 - Strategy 4:** No actions reported.

- **Priority 4 - Strategy 14:** No actions reported.

- **Priority 5 - Strategy 33:** Plant sampling was conducted at Bluegrass and Loon pits and at Bruce, Tippecanoe, and Webster lakes in 2018. Recent estimates of coverage have now been made at all stocked waters except Brookville and Eagle Creek. The date, median coverage is 79% and median dominance (biomass index) is 59. Waters with <63% coverage include Bluegrass, Loon, and Plover pits. Lakes with low coverage are Everett and Skinner. Bluegrass, Plover, and Skinner have the least biomass. Hydro-acoustic sampling was conducted in the main Tippecanoe basin and Lake Webster.

- **Priority 6 - Strategy 28:** Fishing effort and catches reported by Muskie guides for 2017 were summarized, as were results from the annual Indiana Muskie Class tournament held in the Lake Webster area each May. Muskie guided trips and catches have stabilized since the sharp drop-off between 2008 and 2013. The catch of 220 Muskies was the highest of the last five years but the average since 2012 remained 50% below the peak. The catch rate however matched earlier highs. Eighty-five anglers competed in the Classic and caught 30 Muskies ≥30 inches. A Muskie angler provided monthly information on his Muskie fishing effort and catch at Skinner Lake. From April through September her fished 84 hours and caught 15 Muskies averaging 35 inches and ranging from 26-41.5 inches. Anecdotal reports of Muskies catches with photos were also reported at Plover Pit and in Lake Michigan off Michigan City.

- **Priority 7 - Strategy 36:** A summary of long-term trends in Muskie habitat suitability at Lake Webster and at Lake Tippecanoe were prepared.
- **Priority 8 - Strategy 10:** No action reported.

- **Priority 9 - Strategy 44:** No actions reported.

- **Priority 10 - Strategy 9:** Only 227 of the 1,500 age-1 fingerlings (15%) needed for stocking Lake Webster in spring 2018 were recovered from an over-wintering pond at Fawn River Hatchery. However, no attempt was made to locate a supplemental source

given the recent resurgence of the Muskie population at Lake Webster. Poor survival was attributed to competition with surplus steelhead intended as Muskie forage in the pond and a scarcity of fathead minnow forage.

- **Priority 11 - Strategy 1:** Although no steps were taken to develop a back-up broodstock in 2018, on-going VHS testing of various fish species was done at Lake Webster. To date the disease has not been detected but has been responsible for major Muskie die-offs in Michigan. Small clips of tail tissue from 66 Muskies captured at Lake Webster were taken during egg-taking operations and sent to Purdue for DNA analysis. The outcome will help determine how genetically mixed the broodstock population is and provide guidance on steps needed to protect its genetic integrity. To date no results are available.

- **Priority 12 - Strategy 29:** Nine previous creel surveys at Muskies water where fishing interest is relatively high were examined to determine the likelihood of encountering Muskie anglers during May and October, based on randomly selecting nine sampling days per month periods. The results indicated few Muskie anglers (2-3) are likely to be contacted per month at most waters due to low interest, challenging the very basis for stocking.

- **Priority 13 - Strategy 27:** A pilot study of a creel survey design targeting anglers who fish in May and October was conducted at Lake Everett. A previous review of Muskie surveys indicated that more Muskie fishing typically occurs during these two months. The results failed to meet the current success criteria for level of angler interest and catch – See Strategy 11.

- **Priority 14 - Strategy 11:** A targeted Muskie creel survey was conducted at Lake Everett in May and October where spring trap catches failed to meet the plan objective. Results of the survey indicate Muskie fishing interest was low (6%) and few Muskies were caught (4). No Muskies were caught by anglers specifically fishing for Muskies. Two valid anecdotal reports of catches were received in November.

- **Priority 15 - Strategy 12:** No new waters were stocked.

- **Priority 16 - Strategy 23:** Two news releases and a Wild Bulletin feature were developed and issued through the Division of Communications focusing on Indiana Muskie fishing, the genetic study at Lake Webster, and trapping results at Lake Everett. A photo of the largest Muskie trapped at Brookville was posted on the DFW Facebook. A template with suggested content for an Indiana Muskie webpage on the DNR's website was developed but not finalized or posted. A fall Muskie fishing article for Wild Bulletin was also prepared.

- **Priority 17 - Strategy 15:** No actions reported.

- **Priority 18 - Strategy 35:** A summary table listing seven habitat features was created based on recent sampling for all Muskie waters except Brookville and Eagle Creek.

Medians and inter-quartile ranges were calculated to define standards for comparisons between lakes. A scoring system was also established to rank the habitat suitability of various Muskie waters. Three basins in the Barbee Lakes and two pits (Bass and Duck) have the most suitable habitat while Everett and Skinner lakes along with Bluegrass and Loon pits have the least suitable habitat.

- **Priority 19 - Strategy 16:** See Strategy 13.

- **Priority 20 - Strategy 6:** A total of 24,193 age-0 Muskies and 227 age-1 fingerlings were stocked in 13 waters in 2018. An additional 2,173 were stocked into the winter hold-over pond at Fawn River for age-1 Muskie production in 2019. Very few (<1%) of the age-0 Muskies were large enough to meet the minimum requirement (≥10 inches). Mean length of age-0 Muskie stocked into Lake Webster was 8.6 inches (SD=0.5 in). Of those, 67% were less than 9 inches. The inability to produce larger fingerlings was due primarily to less than ideal water quality of East Fork's water supply (Dogwood Lake) and a delay in the timing of the pond culture of the fingerlings due to a delay in the purchase of minnow forage. However, losses of Muskies due to predation by cormorants was minimized.

  Priority 21 - Strategy 5: Although future actions to address this strategy depend in large part on the outcome of DNA analysis, 13 individual female Muskies were used for broodstock in 2018. This exceeded the current 10-fish minimum recommendation.

- **Priority 22 - Strategy 3:** Lake Webster provided 350,000 viable eggs in 2018 resulting in a transfer of 318,000 eggs and 31,000 fry from Fawn River Hatchery to East Fork Hatchery for rearing. Some preliminary communication with the Department of Administration was initiated to possibly obtain a surplus mobile egg-taking vehicle from the Indiana State Police for possible replacement of a rented shed at Webster and for use at other Muskie waters if needed.

- **Priority 23 - Strategy 18:** No actions reported.

- **Priority 24 - Strategy 2:** Work continued on testing the survival of age-0 Muskie fingerlings stocked in the fall versus age-1 fingerlings stocked in the spring at Lake Webster. Although age-1 fingerling production (227 – see Strategy 9) fell far short of the target (1,548), a third batch of 1,540 age-0 fingerlings averaging 8.6 inches were PIT-tagged and stocked into Lake Webster in November. Seventeen tagged Muskies stocked as age-1 fish in 2016 and measuring 24-29 inches were caught during egg-taking operations in April.

- **Priority 25 - Strategy 17:** No actions reported.

- **Priority 26 - Strategy 19:** No actions reported**.**

- **Priority 27 - Strategies 26:** No actions reported.

Priority 28 - Strategy 13: Muskie population assessments based on spring trapping were conducted at Brookville Reservoir, Lake Everett, and Lake Webster in 2018. The results were incorporated into an updated table listing the recent population status at all Indiana Muskie waters except the lower Barbee Lakes, Eagle Creek Reservoir, and main basin of Lake Tippecanoe. Only six Muskies were caught at Brookville (<1/8 sets), five were caught at Everett (4/8 sets) and 126 were caught at Webster (20/8 sets). Although Brookville and Everett were below standard, at least one ≥42 inches was captured at all three waters. The Brookville catch was low due to inconsistent stockings of small fingerlings and low-density stockings of large fingerlings. The Everett catch may have been low due to limited sampling sites but increased with use of a larger trap design. Based on previous catch rates at Webster, a revised estimate of the number of adults currently in the lake was 1,083 (1.4/acre), down from 4,767 (6.2/acre) in 2005.

Priority 29 - Strategy 22: A booth was manned at the Chicago Muskie Expo to increase awareness of Indiana Muskie fishing opportunities on a wide regional basis. Total cost, not counting man-hours, was about $1,500. Pamphlets were prepared and distributed at the event on individual Muskie waters. The National Championship of the Professional Musky Tournament Trail was held Barbee, Tippecanoe, and Webster lakes in October. Many Muskies were caught, especially smaller ones and mostly at Webster Lake.

- **Priority 30 - Strategy 8:** No actions reported.

- **Priority 31 - Strategy 24:** No actions reported.

- **Priority 32 - Strategy 34:** No actions reported.

- **Priority 33 - Strategies 25:** No actions reported.

- **Priority 34 - Strategy 30:** No action reported.

- **Priority 35 - Strategy 42:** A summary of habitat features was presented to the Barbee Association.

- **Priority 36 - Strategy 45:** No actions reported.

- **Priority 37 - Strategy 43:** No actions reported.

- **Priority 38 - Strategy 21:** Targeted spring largemouth bass sampling was conducted at Lake Webster in 2018 as part of the Glacial Lakes Stratus and Trends Project. The results indicate bass abundance may have increased in response to a decline in Muskies, although data from several lakes show overall bass numbers are comparable in stocked and non-stocked lakes but more large bass are present in stocked lakes.

- **Priority 39 - Strategy 31:** No actions reported.

- **Priority 40 - Strategy 37:** No actions reported.

- **Priority 41 - Strategy 38:** No actions reported.

- **Priority 42 - Strategy 47:** No actions reported.

- **Priority 43- Strategy 48:** Woody material was placed in Bass Lake near a fishing pier to provide additional structure habitat for Muskies and other species.

- **Priority 44 - Strategy 20:** No actions reported.

- **Priority 45 - Strategy 39:** Input was provided during reviews of aquatic weed control permits at the Barbee Lakes, Bruce, Skinner, Tippecanoe, and Webster lakes. The annual request for a moratorium on weed control activities during the week leading up the Indiana Muskie Classic tournament was again recognized.

- **Priority 46 - Strategy 46:** No actions reported.

- **Priority 47 - Strategy 40:** No actions reported.

- **Priority 48 - Strategy 41:** No actions reported.

- **Priority 49 - Strategy 49:** No actions reported.

MUSKELLUNGE PROGRAM STATUS - 2018

Priorities of Indiana Muskellunge Management Strategies: The various Muskellunge management strategies were ranked in November 2018 based on the results of an internal poll of 32 fisheries employees within the Division of Fish and Wildlife. Twenty-two individuals responded to the poll. Respondents were asked to consider the feasibility, timeliness, and importance of each strategy and to rank each of these three factors on a 5-point scale from 1 (highest priority) to 5 (lowest priority). An average score for each of the three factors for each strategy was calculated by multiplying the number of respondents who assigned each point to the strategy, summing those values, and then dividing the total score by the number of responses (Appendix 1). For example, the number of respondents who ranked the feasibility of Strategy #1 was as followed:

Rank	Number of responses	Score
1	6	6
2	9	18
3	6	18
4	1	4
5	0	0
Total	22	46
Average		2.09

To generate an overall ranking, the sums of all three factors were then divided by the sum of the responses. For example, Strategy #1 had a feasibility score of 2.09 (46/22), a timeliness score of 2.62 (55/21), and an importance score of 2.18 (48/22), thereby producing an average overall score of 2.92 (149/65).

The average scores for each of the three factors were then ranked, as were the overall scores. The 13 lowest scores were considered high priority strategies and the lowest 13 scores were considered low priority strategies. Those strategies that ranked in-between were considered medium priority. In general, the overall rank provided a good measure of which ones were the highest priority since many of the higher ranking strategies fell at the top as well for each of the three factors. Breaking down the rankings for each of the three factors however, provided insight into how each factor contributed to the overall rank.

Muskie Population Status: Indiana's Muskellunge Strategic Plan calls for the annual production of 19,500 fall age-0 Muskie fingerlings ≥10 inches for stocking 13 designated waters totaling 10, 524 acres and a production of 1,500 spring age-1 fingerlings ≥12 inches for stocking into Lake Webster, the state's broodstock lake. In 2018 a total of 24,193 age-0 Muskies were stocked in each of the 13 waters and 2,137 were stocked into the over-wintering pond at the Fawn River Hatchery for release in 2019 into Lake Webster. Only 227 age-1 Muskies were stocked into Lake Webster. The surplus 5,200 age-0 fingerlings produced in 2018 were stocked into Brookville Reservoir (Appendix 2).

The DNR conducts periodic assessments of adult Muskie populations in stocked waters using traps set in shallow water during the spring spawning season. The results are used to characterize stocking success and make adjustments where needed. Based on prior sampling at 14 waters, stockings are expected to produce a minimum catch of five adults in eight trap sets, including at least one ≥38 inches within eight years and one ≥42 inches within 10 years. For various size groups, catches below the 25th quartile are rated "low" and catches above the 75th quartile are "high". In developing the standards, four waters no longer stocked were included and a random sample was used when multiple samples (years) were available (Appendix 3). In 2018 Muskie population assessments were conducted for the first time Brookville Reservoir and Lake Everett and the 14th time at Lake Webster. Effort consisted of 108 sets of medium traps (IM) in Brookville, eight sets (IM) at Everett plus two large trap (LM) sets, and 51 sets at Webster using a combination of both types of traps.

Only six Muskies were caught at Brookville (<1/8 sets), five were caught at Everett (4/8 sets), and 126 were caught at Webster (20/8 sets) (Appendix 4). All Brookville Muskies were females that were 29-49 inches long, including three legal-size fish (≥36 in). Three Everett Muskies were males (31-32 in) and two were females (30-44 in). Webster Muskies were 24-48 inches, including 33 females that averaged 38 inches. The Brookville catch was low due to inconsistent stockings of small fingerlings and low-density stockings of large fingerlings, as well as uncertainty over where to sample. Five were caught in the south basin. Likewise, 52 were gill-netted during walleye egg-taking along the dam, suggesting gill nets could provide a supplemental population index. Although a 49-inch Muskie was caught, the adjusted catch was 0. Despite few shallow areas at Everett and only eight years of stocking, the catch was near the 5-fish target and included one ≥42 inches. The Webster catch was similar to the 14-year median (24/8 sets). To date overall Muskie populations are sub-par at four waters: Brookville, Bluegrass, Duck and Everett. Sampling is scheduled at the lower Barbee lakes and Eagle Creek Reservoir in 2019.

Muskie Fishing Status: The DNR periodically conducts surveys of Muskie fishing activity at various stocked waters across the state to assess angler effort and Muskie catches. Based on 11 surveys from 2004-2016, Muskie stockings are expected to attract 13% of all boat anglers at each and provide a catch of at least one muskie/17 hours of Muskie fishing. The surveys were chosen from a list of 28 total surveys from 1991-2016 (Appendix 5) to not skew results to waters surveyed multiple times. While the standards are useful to evaluate Muskie stockings at a landscape level, the additional surveys provide more precise data on fishing activity at specific local waters. By including all surveys, the median catch stays the same (1/17 hrs) but the median percentage who fish for Muskies drops to 10%. Developing standards, however, rests on two important issues. Not all surveys were conducted the same way (e.g., 61-273 days) and often cost >$8,000, adding to overall cost of a program that already exceeds the benefits by a 5.2:1 ratio. To standardize the surveys and reduce their cost, the DNR is focusing on May and October, two months that usually draw the most Muskie fishing. Although the 2018 creel survey at Everett Lake provided a potential model on how future Muskie creel data will be collected and analyzed, no final determination of survey protocols have been established. Until then, a non-standardized tally of Muskie creel survey results is presented in Appendix 5. Despite more than 10 years of sampling Brookville Reservoir

and Bluegrass Pit do not meet objective standards in either preference for muskies among anglers or their muskie catch rate. Bass, Skinner, and Upper Long lakes met both standards.

Muskie Habitat Status: Quantitative information on habitat suitability of Indiana waters stocked with Muskies is not well-documented. Ideally stocked waters should be relatively clear, contain a cool-water layer (68-73F) with sufficient oxygen (≥3ppm) during summer, and provide adequate plant cover or woody structure. Until more is known, identifying which waters are least suitable for stocking or best candidates for habitat improvement is difficult. Therefore, the DNR increased efforts in 2018 to gather data on Muskie habitat in 14 of 23 stocked waters. In doing so information is now available at all except Brookville and Eagle Creek reservoirs (Appendix 7). The assessments include water clarity, temperature/oxygen profiles, and plant sampling in August.

Three Barbee Lakes (Irish, Kuhn, Sechrist) are best suited for Muskies (Appendix 8). Two pits (Bass and Duck) also have good habitat. Two other lakes (Everett and Skinner) and two other pits (Loon Pit and Bluegrass) have the least suitable conditions. Oswego and Sechrist are the most clear (≥10 ft). Bruce and Skinner are the least clear (<3 ft). Loon Pit and Bluegrass also have the warmest temperatures (>79F) where oxygen is at a minimum. Seven waters (33%) have no cool-water habitat and Skinner has the least depth of overall fish habitat (7.4 ft). The same five waters with the best habitat have the most plant coverage, most leafy coverage, and biomass (i.e., *dominance*). Bluegrass, Loon Pit, Plover, and Skinner have the least cover.

Appendix 1: Feasibility (Feas), timeliness (Time), and importance (Impo), overall (Rank) ranking scores of 49 Muskellunge management strategies based on responses of 22 Division of Fish and Wildlife fisheries personnel in November 2018. Strategies are listed according to their overall rank (lowest scores). Those highlighted as blue, light-orange, yellow, and green represent the top 25% and are considered high priority. Those highlighted as dark-orange are considered low priority.

Feas	Time	Impo	Rank	Text (Blue, light-orange, yellow, and green indicate high priorities. Dark orange indicates low priorities)
1.591	1.955	2.000	1.848	STRATEGY 32: Identify Muskie waters where a cool-water layer is present based on standardized samp
1.909	1.909	1.857	1.892	STRATEGY 7: Investigate cost-effectiveness of commercial purchases of Muskie fingerlings and forage.
1.667	2.150	2.238	2.016	STRATEGY 4: Explore options to obtain eggs, milt, fry or fingerlings from other state or commercial sour
2.000	2.136	2.136	2.091	STRATEGY 14: Stock optimum waters where emigration, potential habitat and forage limitations, or com
2.000	2.500	2.045	2.182	STRATEGY 33: Quantify aquatic plant coverage and biomass using a standard rake-toss sampling proc
2.095	2.524	1.952	2.190	STRATEGY 28: Use Muskie guide reports and investigate the feasibility of alternative approaches (e.g., t
1.818	2.182	2.682	2.227	STRATEGY 36: Make available the information on temperature, oxygen, and habitat structure at Muskies
2.045	2.136	2.545	2.242	STRATEGY 10: Develop a priority process for allocating fingerlings based on available numbers and size
2.000	2.500	2.318	2.273	STRATEGY 44: Consider alternative Muskie stocking locations where excessive habitat degradation occ
2.095	2.136	2.591	2.277	STRATEGY 9: Maintain contacts with other states and commercial sources for any potential emergency
2.091	2.619	2.182	2.292	STRATEGY 1: Develop a back-up broodstock source and use best management practices to address p
2.045	2.455	2.409	2.303	STRATEGY 29: Refine analysis of past creel surveys to match future targeted surveys to improve standa
2.136	2.818	2.045	2.333	STRATEGY 27: Develop and conduct standardized, targeted, low-cost creel surveys initially within 8 yea
2.227	2.500	2.318	2.348	STRATEGY 11: Rely on measures of angler interest and catches to verify fishable Muskie populations ex
1.909	1.955	3.227	2.364	STRATEGY 12: Only stock new waters that are most readily evaluated by trap-nets.
2.318	2.455	2.318	2.364	STRATEGY 23: Use traditional (e.g., television, print, sport shows, signs) and social media (e,g., email, v
2.091	2.727	2.364	2.394	STRATEGY 15: Adjust stocking strategies where predation, cannibalism, and intra-specific competition r
2.364	2.773	2.136	2.424	STRATEGY 35: Establish standards by which habitat suitability for Muskies can be assessed at various l
2.409	2.545	2.364	2.439	STRATEGY 16: Conduct periodic trap-net assessments at all Muskie waters to confirm success criteria
2.150	2.667	2.571	2.468	STRATEGY 6: Evaluate production process to improve efficiency and security.
2.364	2.727	2.318	2.470	STRATEGY 5: Develop and incorporate a sound broodstock collection, spawning and fish stocking plan t
2.429	2.500	2.500	2.477	STRATEGY 3: Examine broodstock operations, including the possibility of reducing the number of require
2.136	2.591	2.727	2.485	STRATEGY 18: Identify potential limiting factors from responses in the Licensed Angler Survey.
2.364	2.727	2.409	2.500	STRATEGY 2: Adjust stocking strategies (e.g., timing, rate) and regulations (e.g., size, location, season)
2.455	2.773	2.318	2.515	STRATEGY 17: Examine the feasibility of shifting to female-only stockings to increase Muskie growth and
2.136	2.682	2.727	2.515	STRATEGY 19: Conduct targeted surveys of Muskie anglers and non-muskie anglers selected from poin
2.364	2.773	2.409	2.515	STRATEGY 26: Investigate and incorporate effective alternative Muskie marketing programs.
2.273	2.762	2.591	2.538	STRATEGY 13: Conduct an assessment of adult populations within 8 years of initial stocking and repeat
2.409	2.727	2.545	2.561	STRATEGY 22: Work with partners (e.g., Muskie anglers, guides, tournament organizers, lake residents,
2.455	2.864	2.381	2.569	STRATEGY 8: Seek additional funding sources and partner with Muskie anglers to supplement costs.
2.273	2.182	3.273	2.576	STRATEGY 24: Increase awareness, interest, and participation in Muskie fishing through the Record Fish
#DIV/0!	2.955	2.227	2.591	STRATEGY 34: Develop and adopt a technique capable of providing information on the extent and availal
2.636	2.727	2.455	2.606	STRATEGY 25: Evaluate on-going promotional techniques and programs to identify and expand success
2.500	2.727	2.591	2.606	STRATEGY 30: Develop partnerships with Muskie anglers to encourage and enable non-muskie anglers
2.318	2.864	2.636	2.606	STRATEGY 42: Promote the importance of habitat where actions threaten Muskie populations.
2.364	2.818	2.636	2.606	STRATEGY 45: Ensure consideration of potential Muskie habitat improvements with other partners involv
2.727	2.955	2.318	2.667	STRATEGY 43: Develop cooperative relationships between lake residents, managers, and Muskie angler
2.455	2.955	2.727	2.712	STRATEGY 21: Understand and address anti-muskie sentiment and misconceptions that may limit intere
2.636	2.955	2.591	2.727	STRATEGY 31: Determine if alternative waters may be better suited for Muskie stockings to generate su
2.455	3.318	2.545	2.773	STRATEGY 37: Work with partners to promote best management practices through the Lake and River I
2.773	2.955	2.591	2.773	STRATEGY 38: Work with partners to ensure compliance with permit requirements to protect Muskie ha
2.591	3.455	2.273	2.773	STRATEGY 47: Work with partners with various funding sources (e.g., Lake and River Enhancement Pro
2.864	3.045	2.455	2.788	STRATEGY 48: Encourage partners to help organize and fund efforts to install woody material in Muskie
2.409	2.909	3.095	2.800	STRATEGY 20: Determine whether local barriers exist (e.g., lake size, amenities, boating restrictions) th
2.955	3.000	2.455	2.803	STRATEGY 39: Work with lake residents and other partners to maintain sufficient aquatic plant coverage
2.955	2.864	2.682	2.833	STRATEGY 46: Identify and encourage lake associations at Muskie waters who may be interested in red
2.682	3.091	2.773	2.848	STRATEGY 40: Work with lake residents and lake managers to maintain woody material where present i
3.091	3.227	2.909	3.076	STRATEGY 41: Encourage lake residents and partners to establish ecozones (i.e., limited boat areas) w
3.182	3.500	3.227	3.303	STRATEGY 49: Investigate Muskie waters as possible candidates for innovative habitat projects (e.g., ae

Appendix 2. Muskie stockings in 2018.

Waterbody	County	Resource	Acres	N/Acre	N stocked	Initial Year	Regulation
Barbee Lakes Chain	Kosciusko	Glacial Lake	850	5	4250	1998	Standard
Bass	Sullivan	Excavated Lake	222	5	666	1997	Standard
Bluegrass	Warrick	Excavated Lake	195	5	975	2006	Standard
Brookville	Franklin/Union	Impoundment	5260	1	11301	1974	Standard
Bruce	Pulaski	Glacial Lake	245	5	490	2000	Standard
Duck	Sullivan	Excavated Lake	59	5	295	2008	Standard
Eagle Creek	Marion	Impoundment	1350	1	1350	2011	Standard
Everett	Allen	Glacial Lake	43	5	215	2010	Standard
Loon Pit	Warrick	Excavated Lake	184	5	920	2006	Standard
Plover/Sandpiper	Bartholomew	Excavated Lake	84	5	420	1997	Standard
Skinner	Noble	Glacial Lake	125	5	625	1986	Standard
Tippecanoe Chain	Kosciusko	Glacial Lake	1133	1	1133	1997	Standard
Webster[2]	Kosciusko	Glacial Lake	774	4	1825	1981	44-inch
DFW Subtotal	**-**	**-**	**10,524**	**-**	**24,465**	**-**	**-**
Loon[3]	Noble/Whitley	Glacial Lake	222	1	400	1978	Standard
Upper Long[3]	Noble	Glacial Lake	86	2	200	1996	Standard
Statewide Total	**-**	**-**	**10,832**		**25,065**		

[1] *Current stocking rate.*

[2] *includes 1553 age-0 fingerlings and 272 age-1 fingerlings.*

[3] *Permitted private stockings.*

Appendix 3. Adjusted numbers of Muskies of various size group (inches) at 12 waters currently stocked by the Division of Fish and Wildlife standardized to eight trap lifts. Inch groups include <20, 20-29, 30-37, 38-41, 42-49, and 50+. Lifts represent that actual number of trap sets and the Muskie column represents the total actual number of Muskies captured in the actual number of lifts. Note the sum of the adjusted numbers by size do not equal the actual number of captured Muskies. Samples highlighted in light green are from 2018. Samples highlighted in yellow were used in setting the original success criteria in the Strategic Plan.

CURRENTLY STOCKED WATER					Adjusted number by size group						8-set
Water	Year	Lifts	Muskies	N/lift	<S 20	S 20	Q 30	P 38	M 42	T 50	factor
Barbee (Upper)	2015	8	9	1.13	0	0	1	5	3	0	1.00
Bass	2008	3	62	20.67	0	0	112	37	16	0	2.67
Bass	2013	4	14	3.50	0	0	18	10	0	0	2.00
Bass	2016	8	29	3.63	0	0	16	7	6	0	1.00
Bluegrass	2015	6	0	0.00	0	0	0	0	0	0	1.33
Bluegrass	2017	12	0	0.00	0	0	0	0	0	0	0.67
Brookville	2018	108	6	0.06	0	0	0	0	0	0	0.07
Bruce	2012	9	60	6.67	0	0	32	12	10	0	0.89
Bruce	2013	12	90	7.50	0	5	36	15	4	0	0.67
Duck	2016	8	2	0.25	0	0	2	0	0	0	1.00
Everett	2018	10	5	0.50	0	0	3	0	1	0	0.80
Loon Pit	2015	6	7	1.17	0	0	5	4	0	0	1.33
Loon Pit	2017	18	13	0.72	0	1	3	1	0	0	0.44
Plover	2016	12	11	0.92	0	0	3	1	3	0	0.67
Skinner	2008	4	20	5.00	0	0	34	6	0	0	2.00
Skinner	2016	4	16	4.00	0	2	24	4	2	0	2.00
Tippy (James)	2016	7	10	1.43	0	0	1	6	5	0	1.14
Webster	2005	60	931	15.52	0	32	77	10	5	0	0.13
Webster	2006	30	219	7.30	0	8	42	6	3	0	0.27
Webster	2007	66	110	1.67	0	1	9	2	1	0	0.12
Webster	2008	42	185	4.40	0	1	23	9	3	0	0.19
Webster	2009	36	125	3.47	0	4	16	4	4	0	0.22
Webster	2010	24	102	4.25	0	2	25	4	4	0	0.33
Webster	2011	33	152	4.61	0	0	28	6	2	0	0.24
Webster	2012	23	138	6.00	0	1	25	15	7	0	0.35
Webster	2013	74	215	2.91	0	1	14	6	2	0	0.11
Webster	2014	42	140	3.33	0	0	13	8	5	0	0.19
Webster	2015	90	96	1.07	0	0	5	2	1	0	0.09
Webster	2016	52	42	0.81	0	1	3	2	1	0	0.15
Webster	2017	46	88	1.91	0	4	7	2	1	0	0.17
Webster	2018	51	126	2.47	0	5	12	1	2	0	0.16

Appendix 4. Muskie catch, catch by size group (inches), and rank at 12 stocked waters standardized to eight trap lifts. Numbers represent median values when multiple years were sampled. Green cells exceed standards. Yellow cells do not meet standards.

				Adjusted number by size group					
Water	**Score**	**Years**	**Muskies**	**<S 20**	**S 20**	**Q30**	**P38**	**M42**	**T50**
Bruce	5	2	57	0	2	34	13	7	0
Bass	3	3	34	0	0	18	10	6	0
Tippy (James)	3	1	11	0	0	1	6	5	0
Skinner	2	2	36	0	1	29	5	1	0
Webster	2	14	24	0	1	15	5	3	0
Barbee (Upper)	1	1	9	0	0	1	5	3	0
Loon Pit	1	2	8	0	1	4	3	0	0
Plover	1	1	7	0	0	3	1	3	0
Everett	-2	1	4	0	0	3	0	1	0
Duck	-3	1	2	0	0	2	0	0	0
Bluegrass	-4	2	0	0	0	0	0	0	0
Brookville	-4	1	0	0	0	0	0	0	0
Barbee (Lower)	*To be sampled in 2019*								
Eagle Creek	*To be sampled in 2019*								
Tippy (main)	*To be sampled in 2021*								
Comparative standards*									
			Median	0	0	3	1	1	0
			25th Q	0	0	1	0	0	0
			75th Q	0	0	28	6	3	0

Appendix 5. Preference for Muskies (Pref), total hours and hours directed at Muskie fishing per acre per day, Muskie harvest (Har), Muskie releases (Rel), total catch, and Muskie catch rates at various stocked waters in Indiana. Days represent the total number of days from the start of the survey to the end.

Water	Year	Acres	Days	Pref	Muskie Hours	Muskie Hr/100a/d	Har	Rel	Total Catch	Hours/ muskie
Ball*	2008	87	187	17	535	3.3	0	6	6	89.1
Bass	2008	222	273	13	875	1.4	0	83	83	10.5
Big Barbee	2015	304	61	10	429	2.3	0	0	0	0.0
Bluegrass	2012	195	214	0	29	0.1	0	0	0	0.0
Bluegrass	2016	195	263	0	22	0.0	0	23	23	0.9
Brookville	1991	5260	214	0	0	0.0	0	0	0	0.0
Brookville	1994	5260	214	0	367	0.0	13	0	13	28.2
Brookville	2000	5260	194	0	0	0.0	0	0	0	0.0
Brookville	2009	5260	214	0	0	0.0	0	0	0	0.0
Bruce	2005	245	219	10	1070	2.0	0	41	41	26.1
Bruce	2014	245	242	18	1001	1.7	3	18	21	47.7
Everett	2018	43	61	6	0	0	0	4	4	0
Plover/Sandpiper	2005	87	214	5	1227	6.6	6	22	28	43.8
Loon	2004	222	206	12	1737	3.8	9	108	117	14.8
Loon	2009	222	112	6	466	1.9	11	11	22	21.2
Loon Pit	2012	184	214	1	110	0.3	10	73	83	1.3
Loon Pit	2016	184	263	1	112	0.2	0	6	6	18.7
Skinner	1991	125	111	16	1746	12.6	15	115	130	13.4
Skinner	1994	125	107	10	951	7.1	0	264	264	3.6
Skinner	2008	125	199	26	1401	5.6	0	82	82	17.1
Upper Long	2010	86	112	34	1472	15.3	9	136	145	10.2
Upper Long	2015	86	61	45	866	16.5	0	0	0	0.0
Waveland*	2013	358	244	0	11	0.0	0	0	0	0.0
Webster(boat)	1987	774	89	7	1327	1.9	67	201	268	5.0
Webster	1990	774	229	6	3183	1.8	4	86	90	35.4
Webster	1998	774	230	23	10104	5.7	27	501	528	19.1
Webster	2005	774	242	55	38956	20.8	14	2201	2215	17.6
Webster(boat)	2005	774	242	61	39991	21.4	14	2163	2177	18.4
Webster(boat)	2015	774	235	33	11555	6.4	0	556	556	20.8
			Med	10		2.0				17.1
			25Q	0		0.0				0.0
			75Q	25		6.9				21.0

Appendix 6. Muskie creel survey results at 11 currently-stocked Indiana Muskie waters. Numbers represent median values when multiple years were sampled. Green cells exceed standards. Yellow cells denote poor results below the 25th quartile.

Water	Surveys	Preference percentage	Hours/ Muskie
Bass	1	13	10.5
Big Barbee	1	10	0
Bluegrass	1	0	0
Brookville	4	0	0
Bruce	2	12	24
Everett	1	6	2.5
Plover/Sandpiper	1	5	43.8
Loon Pit	2	1	10
Skinner	3	16	13
Upper Long	2	40	5.1
Webster	5	23	19.1
	Q1	3	1
	Med	10	10
	Q3	15	16

Appendix 7. Habitat features at Indiana Muskie lakes. Clarity represents secchi disk depth in feet. F/3ppm represents water temperature at the lowest depth where dissolved oxygen is 3 ppm. Cool and All represent the thickness of cool-water an overall habitat. The last three columns represent overall submersed plant coverage, leafy plant coverage, and dominance index.

			Layer (ft)				Cover (%)		
Water	Date	Clarity	F/3ppm	Cool	All	Date	Plants	Leafy	Dom
Barbee Lakes									
Banning	08/27/18	7.0	74.0	0	10.3	08/27/18	NA	NA	NA
Banning	08/02/10	7.5	79.9	0	8.1	08/02/10	90	90	93
Banning	07/31/06	8.0	NA	NA	NA	07/31/06	73	73	63
Big Barbee	08/27/18	8.5	70.9	1.8	19.4	08/27/18	NA	NA	NA
Big Barbee	08/07/14	5.5	NA	NA	NA	08/07/14	77	77	43
Big Barbee	08/01/06	NA	NA	NA	NA	08/01/06	96	71	91
Irish	08/27/18	8.5	66.5	2.8	21.9	08/27/18	NA	NA	NA
Irish	08/08/14	6.0	NA	NA	NA	08/08/14	78	78	64
Irish	07/31/06	10.0	NA	NA	NA	07/31/06	98	98	100
Kuhn	08/27/18	9.5	70.1	1.3	19.3	08/27/18	NA	NA	NA
Kuhn	08/01/13	8.0	68.6	6.3	17	08/01/13	88	88	88
Kuhn	08/01/06	11.0	NA	NA	NA	08/01/06	88	88	86
Little Barbee	08/27/18	5.0	70.2	5.2	17.2	08/27/18	NA	NA	NA
Little Barbee	08/13/14	3.5	NA	NA	NA	08/13/14	35	35	13
Little Barbee	08/01/06	6.0	NA	NA	NA	08/01/06	93	90	77
Sawmill	08/27/18	5.0	67.0	2.2	18.4	08/27/18	NA	NA	NA
Sawmill	08/13/14	6.0	NA	NA	NA	08/13/14	60	60	35
Sawmill	07/31/06	8.0	NA	NA	NA	07/31/06	98	98	73
Sechrist	08/27/18	8.5	63.5	3.4	21.6	08/27/18	NA	NA	NA
Sechrist	08/15/15	7.0	62.8	2.8	19.9	08/15/15	98	98	119
Sechrist	09/04/14	14.0	71.6	1.5	17.1	09/04/14	NA	NA	NA
Sechrist	08/13/14	11.5	NA	NA	NA	08/13/14	90	90	87
Sechrist	07/31/06	14.5	NA	NA	NA	07/31/06	98	98	90
Sechrist	08/16/99	9.0	72.5	2.6	19.6	08/16/99	NA	NA	NA
Bass	08/01/17	9.0	73.8	0	22.7	08/01/17	93	93	109
Bluegrass	08/01/18	3.1	80.0	0	12.4	08/01/18	52	52	31
Brookville									
Bruce	08/07/18	2.0	77.8	0	8.5	08/07/18	100		72
Bruce	08/08/17	2.0	68.0	8.5	20.9	08/08/17	75	73	34
Bruce	07/26/16	1.5	NA	NA	NA	07/26/16	83	80	51
Bruce	08/25/15	1.5	NA	NA	NA	08/25/15	30	30	10
Bruce	08/25/14	1.5	NA	NA	NA	08/25/14	30	30	10
Bruce	07/29/14	1.5	NA	NA	NA	07/29/14	77	75	47
Bruce	08/01/13	NA	NA	NA	NA	08/01/13	70	65	27
Bruce	07/30/12	NA	NA	NA	NA	07/30/12	93	88	79
Bruce	07/27/11	NA	NA	NA	NA	07/27/11	28	28	9
Bruce	08/25/05	3.0	NA	NA	NA	08/25/05	62	62	27
Duck	08/01/17	7.0	59.2	1.5	25.9	08/01/17	90	88	104
Eagle Creek									
Everett	08/23/18	3.0	75.0	0	9.7	08/23/18	NA	NA	NA
Everett	08/23/12	NA	NA	NA	NA	08/23/12	73	73	62
Everett	08/04/10	9.0	78.5	0	7.5	08/04/10	77	77	53
Everett	07/25/05	3.5	NA	NA	NA	07/25/05	38	30	18
Loon	08/02/12	8.0	72.7	0.1	14.2	08/02/12	78	73	42
Loon	07/30/09	2.5	NA	NA	NA	07/30/09	75	70	53
Loon Pit	08/02/18	3.7	79.1	0	14.2	08/02/18	50	50	24
Plover/Sandpiper	08/13/18	5.5	71.1	0.6	14.8	08/13/18	NA	NA	NA
Plover/Sandpiper	08/03/16	5.5	NA	NA	NA	08/03/16	30	8	25
Skinner	08/13/15	2.0	74.3	0	7.4	08/13/15	26	26	6
Skinner	07/28/08	2.8	NA	NA	NA	07/28/08	46	44	29
Tippecanoe									
James	08/10/17	7.0	71.4	2.6	16.1	08/10/17	83	80	71
Oswego	09/04/14	15.5	71.9	1.5	16.5	08/14/17	73	63	63
Tippecanoe	08/20/18	7.0	69.6	1.9	21.2	08/20/18	NA	NA	NA
Tippecanoe	08/09/18	10.0	NA	NA	NA	08/09/18	79	60	49
Tippecanoe	08/14/17	7.0	72.6	0.4	19.5	08/14/17	82	72	70
Upper Long	08/07/15	4.0	76.7	0	9.5	08/07/15	83	80	60
Upper Long	08/06/10	9.5	NA	NA	NA	08/06/10	93	88	66
Webster	08/22/18	3.5	73.8	0	17.2	08/22/18	77	77	50
Webster	08/08/17	12.0	NA	NA	NA	08/08/17	73	71	48
Webster	08/01/16	4.5	NA	NA	NA	08/01/16	64	62	41
Webster	08/04/15	9.0	NA	NA	NA	08/04/15	78	69	66
Webster	08/28/14	12.0	70.9	2.2	16.7	08/28/14	53	47	41
Webster	08/04/14	8.0	NA	NA	NA	08/04/14	60	54	40
Webster	08/05/13	4.0	NA	NA	NA	08/05/13	41	36	22
Webster	08/07/12	2.5	NA	NA	NA	08/07/12	39	34	16
Webster	08/12/11	3.0	NA	NA	NA	08/12/11	24	21	10
Webster	08/13/10	2.5	NA	NA	NA	08/13/10	80	70	21
Webster	08/01/06	7.0	NA	NA	NA	08/01/06	86	74	59
Webster	07/29/05	8.5	NA	NA	NA	07/29/05	83	69	74

Appendix 8. Average habitat features at Indiana Muskie waters. Green cells indicate good conditions. Yellow cells represent poor conditions.

Indiana muskie waters					Habitat (ft)		Coverage (%)		
Name	Score	Years	Clarity	F/3ppm	Cool	All	Plants	Leafy	Dom
Irish	7	3	8.2	66.5	2.8	21.9	88.0	88.0	82.0
Kuhn	6	3	9.5	69.4	3.8	18.2	88.0	88.0	87.0
Sechrist	6	6	10.8	67.6	2.6	19.6	95.3	95.3	98.7
Duck*	5	1	7.0	59.2	1.5	25.9	90.0	87.5	103.5
Bass	4	1	9.0	73.8	0.0	22.7	93.3	93.3	108.7
Tippecanoe	1	3	8.0	71.1	1.2	20.4	80.6	66.1	59.3
Sawmill	1	3	6.3	67.0	2.2	18.4	79.0	79.0	54.0
Oswego	1	1	15.5	71.9	1.5	16.5	72.5	62.5	62.5
Big Barbee	0	3	7.0	70.9	1.8	19.4	86.5	74.0	67.0
James	0	1	7.0	71.4	2.6	16.1	83.3	80.0	70.7
Loon	0	2	5.3	72.7	0.1	14.2	76.5	71.5	47.5
Little Barbee	0	3	4.8	70.2	5.2	17.2	64.0	62.5	45.0
Bruce	-1	10	1.9	72.9	4.3	14.7	64.8	59.1	36.6
Webster	-1	12	6.4	72.4	1.1	17.0	63.2	57.1	40.5
Upper Long	-3	2	6.8	76.7	0.0	9.5	87.5	83.8	62.8
Plover*	-3	2	5.5	71.1	0.6	14.8	30.0	7.5	24.5
Banning	-3	3	7.5	77.0	0.0	9.2	81.5	81.5	78.0
Everett	-4	4	5.2	76.8	0.0	8.6	62.7	60.0	44.3
Loon Pit*	-6	1	3.7	79.1	0.0	14.2	50.0	50.0	24.4
Skinner	-6	2	2.4	74.3	0.0	7.4	36.0	35.0	17.6
Bluegrass*	-7	1	3.1	80.0	0.0	12.4	52.0	52.0	31.2
Brookville	*Not available*								
Eagle Creek	*Not available*								
		Median	6.8	71.9	1.2	16.5	79.0	71.5	59.3
		25th Q	5.2	70.2	0.0	14.2	63.2	59.1	40.5
		75th Q	8.0	74.3	2.6	19.4	87.5	83.8	78.0

**Contains plant sampling errors.*

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