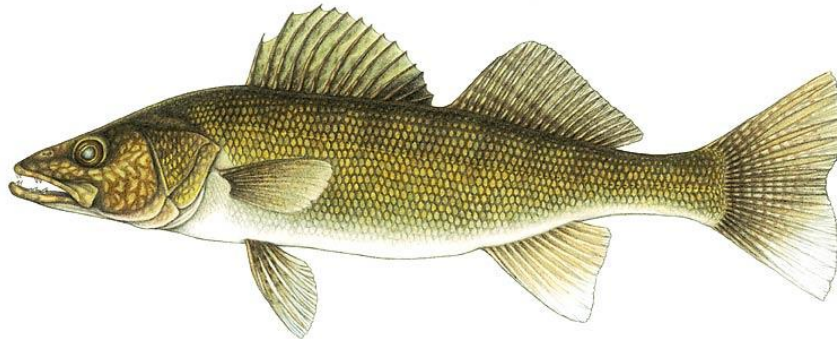


Report for 2021 by the

LAKE ERIE WALLEYE TASK GROUP

March 2022



Prepared:

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Note: *Data and management summaries contained in this report are provisional. Every effort has been made to ensure their correctness. Contact individual agencies for complete state and provincial data.*

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Charges to the Walleye Task Group, 2021-2022

The charges from the Lake Erie Committee's (LEC) Standing Technical Committee (STC) to the Walleye Task Group (WTG) for the period of April 2021 to March 2022 were to:

1. Maintain and update the centralized time series of datasets:
 - a. Required for bi-national population models and assessment and
 - b. Produce the annual Recommended Allowable Harvest (RAH)
2. Support LEC Walleye management efforts by:
 - a. Maintain working knowledge of the most current academic and agency research related to Lake Erie Walleye population assessment and modeling including estimating and forecasting:
 - Abundance
 - Age/size/spatial stock structure (migration rates)
 - Recruitment and mortality (M)
 - b. Provide critical evaluation and guidance for incorporating new research into Lake Erie Walleye management to produce the most scientifically sound and reliable population models.
 - c. Support analysis and review of Walleye Management Plan and assessment models for potential 2024 renewal.

Review of Walleye Fisheries in 2021

2021 fishery performance and characteristics

Fishery effort and Walleye harvest data were combined for all fisheries, jurisdictions and Management Units (MUs) (Figure 1) to produce lake-wide summaries. The 2021 total estimated lake-wide harvest was 7.973 million Walleye (Table 1), of which 7.611 million were harvested in the total allowable catch (TAC) area. This TAC-area harvest represents 62% of the 2021 TAC (12.284 million Walleye) and includes Walleye harvested in commercial and sport fisheries in MUs 1-3. An additional 0.362 million Walleye (5% of the lake-wide total) were harvested outside of the TAC area in MUs 4&5 (Table 1). The estimated sport Walleye harvest was 2.944 million fish in 2021; harvest in 2021 was above the long-term mean (1975-2020 = 2.297 million Walleye; Table 2).

The 2021 Ontario commercial harvest was 5.042 million Walleye lake-wide, with 4.869 million caught in the TAC area (Table 2). The 2021 Ontario angler estimates of harvest and effort were derived from the 2014 lake-wide aerial creel survey because angler creel surveys are not conducted annually in Ontario waters. It assumes 71,000 Walleye were harvested in Ontario within the TAC area during 2021, which is included in total Walleye harvest, but not used in catch-at-age analysis. Total harvest of Walleye in Ontario TAC waters was 4.941 million Walleye, representing 93% of Ontario's 2021 TAC allocation of 5.289 million Walleye. In 2021, the lake-wide Ontario commercial harvest was above the long-term average (1976-2020 = 2.144 million Walleye; Table 2, Figure 2). Similarly, lake-wide harvest was well above the current Walleye Management Plan's performance metric of at least 4.0 million pounds of commercial yield (2021 commercial harvest = 11.5 million pounds).

Lake-wide sport fishing effort decreased slightly in 2021 to 3.933 million angler hours (Table 3, Figure 3). Sport effort increased in MU1, but declined in MUs 2-5 (Table 3, Figure 4). Despite the drop in effort, the 2021 lake-wide average sport harvest per unit effort (HUE) increased to 0.73 Walleye/angler hour and remained above both the long-term (1975-2020) average of 0.45 Walleye/angler hour and the

current Walleye Management Plan's performance metric of 0.40 Walleye/angler hour (Table 4, Figure 5). In 2021, the sport HUE remained above long-term averages in all MUs (Table 4).

The total commercial gill net HUE increased in 2021 (277 Walleye/kilometer of gill net) and remained above the long-term (1976-2020) lake-wide average (128 Walleye/kilometer of net; Table 4, Figure 5). Commercial gill net harvest rates increased in all areas of Lake Erie, with all MUs' HUE well above the long-term averages (Table 4).

Lake-wide harvest in the commercial fishery was composed of age 6 Walleye from the 2015 (36%) year class, along with large contributions from age 2 and age 3 Walleye from the 2019 (27%) and 2018 (22%) year classes, respectively (Table 5; Table 6). The mean age of fish caught in the 2021 commercial fishery has remained steady since 2019 and was near long-term average (Table 7, Figure 6). Age composition of the lake-wide sport harvest was more varied, with age 3 Walleye (29%; 2018 year class) and age 6 Walleye (23%; 2015 year class) making the largest contributions, with age 4 (16%; 2017 year class) and age 5 (17%; 2016 year class) fish also contributing to the sport fishery (Table 6, Figure 6).

Statistical Catch-at-Age Analysis (SCAA): Abundance

The WTG uses a SCAA model to estimate the abundance of Walleye in Lake Erie from 1978 to 2021. This model estimates population abundance of age 2 and older Walleye using fishery-dependent and fishery-independent data sources, which includes fishery-dependent data from the Ontario commercial fishery (MU 1-3) and sport fisheries in Ohio (MU 1-3) and Michigan (MU1), along with data collected from three fishery-independent gill net surveys (i.e., Ontario Partnership, Michigan, and Ohio).

Summary of 2022 SCAA model results

Based on the 2022 SCAA model, the 2021 west-central population (MU1-3) was estimated at 83.1 million age 2 and older Walleye (Table 8, Figure 7). An estimated 38.2 million age 2 (2019 year class) fish comprised 46% of the age 2 and older Walleye population. Age 3 (2018 year class) Walleye represented the second largest (22%) and age 6 (2015 year class) the third largest (19%) components of the population. The number of age 2 recruits entering the population in 2022 (2020 year class) and 2023 (2021 year class) are projected to be 21.1 and 59.0 million Walleye, respectively (Table 9). The 2022 abundance of age 2 and older Walleye in the west-central population is projected to be 75.7 million fish (Table 8; Figure 7).

Harvest Policy and Recommended Allowable Harvest (RAH) for 2022

In March 2022, the WTG applied the following Harvest Control Rules as identified in the Walleye Management Plan (WMP; 2015-2024):

- *Target Fishing Mortality* of **60%** of the fishing mortality Maximum Sustainable Yield ($60\%F_{MSY}$);
- *Threshold Limit Reference Point* of **20%** of the Unfished Spawning Stock Biomass ($20\%SSB_0$);
- Probabilistic Control Rule, P-star, $P^* = 0.05$;
- A limitation on the annual change in TAC of $\pm 20\%$.

Using results from the 2022 SCAA model, the estimated abundance of 75.749 million age-2 and older Walleye in 2022, and the harvest policy described above, the calculated mean RAH for 2022 was 14.533 million Walleye, with a range from 11.498 (minimum) to 17.568 (maximum) million Walleye (Table 9). The WTG RAH range estimate is an AD Model Builder (ADMB, Fournier et al. 2012) generated value based on estimating \pm one standard deviation of the mean RAH. AD Model Builder uses a statistical technique called the delta method to determine this standard deviation for the calculated RAH, incorporating the standard errors from abundance estimates at age and combined gear selectivity at age. The target fishing rate ($60\%F_{MSY} = 0.334$) in the harvest policy was applied because the probability of the projected spawner biomass in 2023 (65.047 million kg) falling below the limit reference point ($20\%SSB_0 = 12.470$ million kg) after fishing at $60\%F_{MSY}$ in 2022 was less than 5% ($p < 0.001$). Thus, the probabilistic control rule (P^*) to reduce the target fishing rate and conserve spawner biomass was not invoked during the 2022 determination of RAH.

In addition to the RAH, the Harvest Control Rule adopted by LEPMAG limits the annual change in TAC to $\pm 20\%$ of the previous year's TAC. According to this rule, the maximum change would be + or - 20% of the 2021 TAC (12.284 million fish), and the range in 2022 TAC for LEC consideration ranges from 9.827 to 14.741 million Walleye.

Other Walleye Task Group Activities

The following represents WTG progress and developments on Charge 2a and 2b. During 2021-2022, this work focused on (1) *Movements, Migrations and Spatial Ecology*, (2) *Stock Structure*, (3) *Recruitment*.

Movements, Migration and Spatial Ecology

Since 2011, WTG members have participated collaboratively in several Great Lakes Acoustic Telemetry Observation System (GLATOS; <https://glatos.glos.us/>) studies across Lake Erie. Insights from this ongoing work help to inform an evolving understanding of such things as stock contributions to mixed fisheries (see Stock Structure, below), spawning site fidelity, rates of skipped spawning, and spawning phenology. WTG members, together with colleagues from the University of Windsor, Michigan State University, USGS, and Ohio State University, anticipate publishing manuscripts dealing with seasonal occupancy of Walleye by basin, along with spawning site fidelity and phenology in the coming year.

Stock structure

In recent years there has been an effort to improve our understanding of Walleye stock structure at the lake-wide scale to inform future iterations of the Walleye management plan. One of the major information gaps associated with Walleye stock structure is how western and eastern basin stocks interact to influence fisheries and survey results in the eastern basin.

Previous attempts to use genetic approaches to determine relative stock contributions to mixed fisheries in Lake Erie have been confounded by an inability to discriminate between individual spawning aggregations due to weak spawning stock genetic structure. By focusing on more coarse stock structure using next-generation sequencing technologies (i.e., RAD sequencing; Rapture Panels) it has recently become possible to accurately discriminate stock structure at a basin-level scale. Individual fish can be accurately assigned to basin of origin with 89-99% accuracy. This coarser level of discrimination was sufficient to address questions about local and migratory (western and central basin) stock contributions to eastern basin fisheries.

Walleye Task Group members, together with colleagues from the University of Wisconsin-Stevens Point, Ohio State University and the Aquatic Research and Development Section of OMNDNRF used these techniques to assign proportional contributions by basin (eastern or central/western), to the commercial and sport fisheries of the eastern basin in 2017, with some inclusion of the 2016 and 2018 fisheries (Euclide et al, 2020). Previous tagging studies demonstrated that western origin fish contribute significantly to eastern fisheries. This work largely confirmed that finding, while also quantifying annual, seasonal, and spatial variability in these contributions. In fact, eastern basin Walleye stocks can have a larger influence on eastern basin fisheries than previously thought and likely contribute substantially to harvest during particular times and in particular locals.

In general, the largest contributions of western stocks to eastern fisheries occur between July and September. However, July contributions varied between 20% (2016) and 90% (2018). Western basin stocks constituted most of the harvest during the peak Walleye fishing season (July – September), whereas eastern basin individuals comprised much of the early season harvest (May – June). Furthermore, catches in more easterly sites contained more individuals of eastern basin origin than did more westerly sites. Notable differences were found between the commercial fishery in Ontario waters and the sport fishery in New York waters.

The results to date indicate that periodic reassessments of stock contributions to the harvest are likely necessary to characterize longer-term spatio-temporal variation in relative stock contributions. Contributions under current conditions of high lake-wide population abundance may be particularly informative and ultimately this work is expected to inform management decisions and facilitate incorporation of the eastern basin into the lake-wide management framework.

In 2021, both eastern fisheries were re-sampled with the intent of using the same genetic techniques to again examine contributions from the basin level categories. Ontario's commercial gillnet fishery was sampled extensively enough to examine harvest from the targeted Walleye fishery as well as that caught incidentally in the targeted Yellow Perch fishery. Commercial fishery samples were collected from May through December. New York's sport fishery was sampled extensively during June and July. All samples were sent to the OMNDMNR Aquatic Genetics lab in Peterborough where they were genotyped using a GTseq panel of 500 SNPs developed for walleye in the Great Lakes (Euclide et al. 2021b). Source assignment and mixed-stock analyses are underway (March 2022).

Additionally, in 2021 task group members opportunistically collected young-of-year Walleye from a variety of assessment programs across all basins. Plans are underway to use similar basin-scale genetic assignments in 2022 to gain insight into the extent of dispersal from basins of origin and potentially to spotlight unique signatures where small but unique stocks might exist.

Recruitment

Evidence of multiple Walleye stocks in Lake Erie exists, with decreasing stock productivity from west to east. However, migrations and mixing of stocks throughout the lake make evaluation of individual stock productivity difficult. For example, adult Walleye from western basin spawning grounds in the spring migrate to the cooler waters of the central and eastern basins in the summer, and then return to the west basin before spawning. While juvenile Walleye from both the western and eastern basin are believed to disperse from natal basins during the summer and fall, it is unknown if their migrations are similar to those of adults. To address uncertainty surrounding juvenile dispersal and productivity of Walleye stocks across Lake Erie, the WTG has reported basin-specific densities of yearling Walleye with standardized gill net indices since 2011 (WTG 2012).

In Figure 8, site-specific yearling Walleye catches are presented for the bottom set interagency (ON, NY) monofilament nets; suspended (canned or keged) Ohio monofilament nets; suspended Michigan multifilament nets; and suspended Ontario monofilament nets fished in 2021. Catches were standardized for net length (50 ft [15.2 m] panels) of mesh sizes ≤ 5.5 " (140 mm) but correction factors were not applied to standardize fishing power between monofilament and multifilament nets. New York and Ontario monofilament nets share the same configurations with the exception that Ontario nets contain 2 panels instead of the one 50 ft (15.2 m) panel for mesh sizes ≥ 2 " (51 mm). New York's index gill nets were fished exclusively on bottom and were confined to shallower depths than nets fished in Ontario's waters of eastern Lake Erie (Figure 8a). Catches in Ontario canned nets plotted include standard canned nets but excluded nets canned in the thermocline in the east basin and Pennsylvania Ridge surveys.

In 2021, yearling (2020 year class) Walleye catches occurred lake-wide where index nets were fished (Figures 8a and b). Yearlings were present in bottom and suspended nets and in nearshore and offshore areas. In the western basin interagency August trawl survey, yearling catch rates were 5th highest in the time series (14.4 fish/Ha). With few exceptions, most agency assessments ranked yearling walleye abundance in 2021 above their respective median catch rates. Based on Ontario's Partnership gillnet survey, yearlings were ranked 11th in the west/central part of the lake and were 5th highest in the east including the Pennsylvania Ridge the time series. New York gillnet survey yearling catches in the east were moderate, ranked as 63rd percentile in the time series.

Similar to recent years, mean lengths of age 0 (103 mm) and age 1 (212 mm) Walleye from western basin interagency bottom trawls during August 2021 were below average (Figure 9). This trend of declining size was also observed in agency gill net surveys at ages 1 through 4 as Walleye showed decreased mean size at age in recent years (Figure 10). These changes are likely related to the increased abundance of Walleye, which has been driven by several large year classes since 2015. As these fish enter the fisheries in 2022 at smaller than usual sizes, the WTG expects to see an increased release rate in the sport fisheries (because anglers may encounter many sub-legal Walleye) and that these smaller fish will exhibit delayed vulnerability to commercial Walleye gill net fisheries.

Currently, the young-of-the-year (YOY) index from the interagency west basin bottom trawl survey (Table 10) is integrated into the SCAA model to estimate age-2 Walleye abundance and forecast recruitment. In 2021, the YOY catch rates (reported as the number of YOY Walleye caught per hectare trawled) were the highest in time series (345.6 fish per hectare; Table 10). Although the YOY catch at a single site was exceptionally high, this year class ranks as one of the strongest regardless of whether this catch was included. Indices throughout the lake varied in 2021; some of the 2021 YOY catch rates were also high in the central and eastern basin trawl and gill net surveys. While the interagency bottom trawl survey is a robust recruitment predictor, inclusion of additional YOY and yearling indices to form a composite recruitment index could supplement recruitment estimates. However, there are two factors limiting the integration of a composite recruitment index into the SCAA model:

1. Yearling indices are not available far enough in advance to forecast age-2 recruitment in the year following harvest, as required for assessing risk (i.e., P^*) in the current Walleye Management Plan's probabilistic harvest control rule (Kayle et al. 2015). Options for overcoming this limitation would be exclusion of yearling indices from a composite recruitment index, running two integrated SCAA models (one with YOY and yearling data and the second model using only YOY data), or ignoring risk (i.e., removal of P^*) from the Walleye Management Plan Harvest Policy. It is important to note that the two SCAA model options could result in conflicting abundance estimates.
2. Spatial, temporal, and gear type (bottom set vs. suspended gill nets) variability exist in Walleye YOY and yearling indices, along with inconsistencies in sampling intensity and effort. Previous examination of the available recruitment indices using a Principal Components Analysis (PCA) approach revealed challenges for integrating a composite recruitment index into the SCAA model (WTG 2016). Data transformations and missing years of data in some indices were primary concerns.

The WTG will continue to update the dataset of recruitment indices. However, composite Walleye recruitment indices will not be presented until concerns related to data transformations, missing years of data, and recent changes in index gear configuration are addressed. The WTG will also continue to explore and evaluate alternative recruitment estimation approaches to be considered for adoption in future Lake Erie Walleye Management Plans.

WTG Centralized Datasets

WTG members currently manage several databases that consist of fishery-dependent and fishery-independent surveys conducted by the respective agencies. Annually, data are compiled by WTG members to form spatially-explicit versions of agency-specific harvest data (e.g., harvest-at-age and fishery effort by management unit) and population assessment (e.g., the interagency trawl program and gill net surveys) databases. These databases are used for trends and status evaluations, estimating population abundance, and to inform the decision-making process regarding RAH. Ultimately, annual population abundance estimates are used to assist LEC members with setting TACs for the upcoming year and evaluate past harvest policy decisions. Use of WTG databases by non-members is only permitted following a specific protocol established in 1994, described in the 1994 WTG Report and reprinted in the 2003 WTG Report (WTG 2003).

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Table 1. Annual Lake Erie walleye total allowable catch (TAC, top) and measured harvest (Har; bottom, bold), in numbers of fish from 2011 to 2021. TAC allocations are based on water area: Ohio, 51.11%; Ontario, 43.06%; and Michigan, 5.83%. New York and Pennsylvania do not have assigned quotas, but are included in annual total harvest.

Year		TAC Area (MU-1, MU-2, MU-3)				Non-TAC Area (MUs 4&5)				All Areas Total
		Michigan	Ohio	Ontario ^a	Total	NY	Penn.	Ontario	Total	
2011	TAC	170,178	1,491,901	1,256,921	2,919,000				0	2,919,000
	Har	50,490	417,314	1,224,057	1,691,861	31,506	45,369	28,873	105,748	1,797,609
2012	TAC	203,292	1,782,206	1,501,502	3,487,000				0	3,487,000
	Har	86,658	921,390	1,355,522	2,363,570	36,975	44,796	28,260	110,031	2,473,601
2013	TAC	195,655	1,715,252	1,445,094	3,356,000				0	3,356,000
	Har	54,167	1,083,395	1,274,945	2,412,507	34,553	60,332	30,591	125,476	2,537,983
2014	TAC	234,774	2,058,200	1,734,026	4,027,000				0	4,027,000
	Har	42,142	1,303,133	1,324,201	2,669,476	61,982	84,843	52,675	199,500	2,868,977
2015	TAC	239,846	2,102,665	1,771,488	4,114,000				0	4,114,000
	Har	65,740	1,073,263	1,382,600	2,521,603	55,201	46,523	89,882	191,606	2,713,209
2016	TAC	287,827	2,523,301	2,125,872	4,937,000				0	4,937,000
	Har	65,816	855,820	1,959,573	2,881,209	50,963	32,937	112,743	196,643	3,077,852
2017	TAC	345,369	3,027,756	2,550,874	5,924,000				0	5,924,000
	Har	56,938	1,261,327	3,232,817	4,551,082	70,010	162,949	129,217	362,176	4,913,258
2018	TAC	414,455	3,633,410	3,061,135	7,109,000				0	7,109,000
	Har	176,089	1,972,295	3,478,713	5,627,097	123,503	270,189	263,204	656,896	6,283,993
2019	TAC	497,357	4,360,194	3,673,449	8,531,000				0	8,531,000
	Har	153,171	2,558,359	3,362,053	6,073,583	174,466	419,975	229,466	823,907	6,897,490
2020	TAC	716,157	6,278,352	5,289,490	12,284,000				0	12,284,000
	Har	191,490	1,973,038	3,680,335	5,844,863	84,615	208,760	243,175	536,550	6,381,413
2021	TAC	716,000	6,278,352	5,289,490	12,284,000				0	12,284,000
	Har	177,948	2,492,386	4,940,829	7,611,163	43,772	145,261	173,205	362,238	7,973,401

^a Ontario sport harvest values were estimated from the 2014 lakewide aerial creel survey. These values are included in Ontario's total walleye harvest, but are not used in catch-at-age analysis.

Table 2. Annual harvest (thousands of fish) of Lake Erie walleye by gear, management unit, and agency from 2011 to 2021. Means contain data from 1975 to 2020.

Year	Sport Fishery															Commercial Fishery					Grand Total
	Unit 1				Unit 2			Unit 3			Units 4 & 5				Total	Unit 1	Unit 2	Unit 3	Unit 4	Total	
	OH	MI	ON ^a	Total	OH	ON ^a	Total	OH	ON ^a	Total	ON ^a	PA	NY	Total		ON	ON	ON	ON		Total
2011	224	50	44	318	104	2	106	89	0	90	2	45	32	79	593	736	262	181	29	1,208	1,801
2012	596	87	44	726	233	2	235	93	0	93	2	45	37	84	1,138	834	285	191	28	1,338	2,476
2013	757	54	44	855	190	2	192	136	0	136	2	60	35	97	1,280	737	297	195	31	1,260	2,540
2014	909	42	45	996	177	13	190	218	13	231	13	85	62	160	1,577	756	259	238	40	1,292	2,869
2015	746	66	45	857	187	13	200	140	13	153	13	47	55	115	1,325	633	354	325	77	1,388	2,713
2016	577	66	45	688	139	13	152	140	13	153	13	33	51	97	1,090	946	594	348	100	1,988	3,078
2017	592	57	45	694	316	13	330	353	13	367	13	163	70	246	1,636	1,735	918	508	116	3,277	4,913
2018	955	176	45	1,177	666	13	679	351	13	365	13	270	124	407	2,627	1,523	1,433	451	250	3,657	6,284
2019	1,297	153	45	1,495	947	13	960	314	13	328	13	420	174	607	3,391	1,666	1,237	387	217	3,507	6,897
2020	537	191	45	774	908	13	921	528	13	541	13	209	85	306	2,543	1,938	1,185	486	230	3,839	6,381
2021	1,318	178	45	1,541	810	13	824	364	13	377	13	145	44	202	2,944	2,750	1,375	745	173	5,042	7,986
Mean	1,433	245	41	1,719	305	10	312	187	12	196	9	98	47	91	2,297	1,386	501	304	66	2,144	4,441

^a Ontario sport harvest values were estimated from the 2014 lakewide aerial creel survey. These values are included in Ontario's total walleye harvest, but are not used in catch-at-age analysis.

Table 3. Annual fishing effort for Lake Erie walleye by gear, management unit, and agency from 2011 to 2021. Means contain data from 1975 to 2020.

Year	Sport Fishery ^a															Commercial Fishery ^b				
	Unit 1				Unit 2			Unit 3			Units 4 & 5				Total	Unit 1	Unit 2	Unit 3	Units 4&5	Total
	OH	MI	ON ^c	Total	OH	ON ^c	Total	OH	ON ^c	Total	ON ^c	PA	NY	Total		ON	ON	ON	ON	
2011	862	165	--	1,026	346	--	346	217	--	217	--	156	145	301	1,891	2,646	1,884	1,572	489	6,591
2012	1,283	242	--	1,525	560	--	560	182	--	182	--	160	169	329	2,597	4,674	2,480	2,298	352	9,804
2013	1,424	182	--	1,606	503	--	503	236	--	236	--	154	143	297	2,641	3,802	2,774	2,624	304	9,503
2014	1,552	131	101	1,683	459	85	459	441	71	441	70	171	187	358	2,940	7,351	4,426	2,911	254	14,943
2015	1,430	165	--	1,595	564	--	564	341	--	341	--	162	215	377	2,876	6,980	6,487	5,379	792	19,637
2016	1,514	236	--	1,750	439	--	439	397	--	397	--	141	217	358	2,944	6,980	7,969	4,523	1,448	20,920
2017	1,351	187	--	1,538	726	--	726	501	--	501	--	228	213	441	3,207	8,056	7,239	3,636	1,527	20,458
2018	1,239	261	--	1,500	813	--	813	354	--	354	--	248	229	477	3,144	5,215	7,421	2,636	1,896	17,168
2019	1,739	265	--	2,004	1,036	--	1,036	307	--	307	--	439	297	736	4,083	4,165	6,365	2,402	1,353	14,285
2020	1,111	301	--	1,413	1,511	--	1,511	659	--	659	--	395	279	674	4,257	5,759	6,576	3,049	1,738	17,122
2021	1,630	325	--	1,955	1,087	--	1,087	450	--	450	--	258	183	441	3,933	7,279	6,528	3,168	1,236	18,212
Mean	2,806	639	102	3,502	772	62	786	418	111	448	106	227	234	292	4,978	8,602	5,694	4,360	804	18,585

^a Ohio, Michigan, Pennsylvania and New York sport units of effort are thousands of angler hours.

^b Estimated Standard (Total) Effort in kilometers of gill net = (walleye targeted effort x walleye total harvest) / walleye targeted harvest.

^c Ontario sport fishing effort was estimated from 2014 lakewide aerial creel survey, values are in rod hours

^d Ontario sport fishing effort is not included in area and lakewide totals due to effort reporting in rod hours

Table 4. Annual catch per unit effort for Lake Erie walleye by gear, management unit, and agency. Means contain data from 1975 to 2020.

Year	Sport Fishery ^a															Commercial Fishery ^b					
	Unit 1				Unit 2			Unit 3			Units 4 & 5					Total	Unit 1	Unit 2	Unit 3	Unit 4	Total
	OH	MI	ON ^c	Total	OH	ON ^c	Total	OH	ON ^c	Total	ON ^c	PA	NY	Total	ON		ON	ON	ON		
2011	0.26	0.31	--	0.27	0.30	--	0.30	0.41	--	0.41	--	0.29	0.22	0.26	0.29	278.3	138.9	115.0	59.0	183.3	
2012	0.46	0.36	--	0.45	0.42	--	0.42	0.51	--	0.51	--	0.28	0.22	0.25	0.42	178.4	114.8	83.1	80.3	136.5	
2013	0.53	0.30	--	0.51	0.38	--	0.38	0.58	--	0.58	--	0.39	0.24	0.32	0.47	194.0	107.0	74.2	100.7	132.5	
2014	0.59	0.32	0.45	0.56	0.39	0.16	0.39	0.49	0.19	0.49	0.18	0.50	0.33	0.41	0.51	102.8	58.4	81.8	156.8	86.5	
2015	0.52	0.40	--	0.51	0.33	--	0.33	0.41	--	0.41	--	0.29	0.26	0.27	0.43	90.6	54.5	60.3	97.3	70.7	
2016	0.38	0.28	--	0.37	0.32	--	0.32	0.35	--	0.35	--	0.23	0.23	0.23	0.34	135.5	74.6	77.0	69.0	95.0	
2017	0.44	0.30	--	0.42	0.44	--	0.44	0.70	--	0.70	--	0.71	0.33	0.53	0.48	215.3	126.9	139.6	76.2	160.2	
2018	0.77	0.67	--	0.75	0.82	--	0.82	0.99	--	0.99	--	1.09	0.54	0.83	0.81	292.0	193.1	171.0	132.0	213.0	
2019	0.75	0.58	--	0.72	0.91	--	0.91	1.02	--	1.02	--	0.96	0.59	0.81	0.81	399.9	194.4	161.3	160.1	245.5	
2020	0.48	0.64	--	0.52	0.60	--	0.60	0.80	--	0.80	--	0.53	0.30	0.44	0.58	336.5	180.2	159.3	132.5	224.2	
2021	0.81	0.55	--	0.77	0.75	--	0.75	0.81	--	0.81	--	0.56	0.24	0.43	0.73	377.7	210.6	235.0	140.1	276.9	
Mean	0.49	0.38	0.40	0.47	0.36	0.26	0.36	0.43	0.19	0.42	0.11	0.39	0.20	0.28	0.45	182.55	93.92	79.29	78.57	128.1	

^a Ohio, Michigan, Pennsylvania and New York sport CPE = Number/angler hour

^b Commercial CPE = Number/kilometer of gill net

^c Ontario sport fishing CPE was estimated from the 2014 lakewide aerial creel survey values are in number/rod hour

^d Ontario sport fishing CPE is not included in area and lakewide totals due to effort reporting in rod hours

Table 5. Catch at age of walleye harvest by management unit, gear, and agency in Lake Erie during 2021.
Units 4 and 5 are combined in Unit 4.

Unit	Age	Commercial	Sport				Total	All Gear Total
		Ontario	Ohio	Michigan	New York	Pennsylvania		
1	1	74,933		0			0	74,933
	2	679,722	41,732	5,006			46,738	726,460
	3	570,679	349,783	36,149			385,932	956,611
	4	161,884	199,221	30,993			230,214	392,098
	5	74,922	200,710	17,351			218,061	292,983
	6	1,071,257	300,108	67,886			367,994	1,439,251
	7+	116,179	226,538	20,561			247,099	363,278
Total		2,749,576	1,318,092	177,948	--	--	1,496,040	4,245,616
2	1	1,011					0	1,011
	2	236,117	30,445				30,445	266,562
	3	406,787	287,569				287,569	694,356
	4	93,979	120,489				120,489	214,468
	5	29,361	140,827				140,827	170,188
	6	576,279	176,001				176,001	752,280
	7+	31,209	55,094				55,094	86,303
Total		1,374,743	810,425	--	--	--	810,425	2,185,168
3	1	49,515					0	49,515
	2	385,760	11,498				11,498	397,258
	3	117,229	98,487				98,487	215,716
	4	21,731	63,164				63,164	84,895
	5	3,529	90,371				90,371	93,900
	6	152,093	72,087				72,087	224,180
	7+	14,876	28,261				28,261	43,137
Total		744,733	363,868	--	--	--	363,868	1,108,601
4	1	22,529					0	22,529
	2	71,422			0	3,228	3,228	74,650
	3	28,587			7,490	54,876	62,367	90,954
	4	3,322			7,239	20,982	28,222	31,544
	5	3,590			12,528	16,140	28,668	32,258
	6	33,026			9,200	45,192	54,392	87,418
	7+	10,716			7,315	4,842	12,157	22,873
Total		173,192	--	--	43,772	145,261	189,033	362,225
All	1	147,988	0	0	0	0	0	147,988
	2	1,373,021	83,675	5,006	0	3,228	91,909	1,464,930
	3	1,123,282	735,839	36,149	7,490	54,876	834,355	1,957,637
	4	280,916	382,874	30,993	7,239	20,982	442,089	723,005
	5	111,402	431,908	17,351	12,528	16,140	477,927	589,329
	6	1,832,655	548,196	67,886	9,200	45,192	670,474	2,503,129
	7+	172,980	309,893	20,561	7,315	4,842	342,611	515,591
Total		5,042,244	2,492,385	177,948	43,772	145,261	2,859,366	7,901,610

Table 6. Age composition (in percent) of walleye harvest by management unit, gear, and agency in Lake Erie during 2021. Units 4 and 5 are combined in Unit 4.

Unit	Age	Commercial	Sport				Total	All Gears
		Ontario	Ohio	Michigan	New York	Pennsylvania		Total
1	1	2.7	0.0	0.0	--	--	0.0	1.8
	2	24.7	3.2	2.8	--	--	3.1	17.1
	3	20.8	26.5	20.3	--	--	25.8	22.5
	4	5.9	15.1	17.4	--	--	15.4	9.2
	5	2.7	15.2	9.8	--	--	14.6	6.9
	6	39.0	22.8	38.1	--	--	24.6	33.9
	7+	4.2	17.2	11.6	--	--	16.5	8.6
Total		100.0	100.0	100.0	--	--	100.0	100.0
2	1	0.1	0.0	--	--	--	0.0	0.0
	2	17.2	3.8	--	--	--	3.8	12.2
	3	29.6	35.5	--	--	--	35.5	31.8
	4	6.8	14.9	--	--	--	14.9	9.8
	5	2.1	17.4	--	--	--	17.4	7.8
	6	41.9	21.7	--	--	--	21.7	34.4
	7+	2.3	6.8	--	--	--	6.8	3.9
Total		100.0	100.0	--	--	--	100.0	100.0
3	1	6.6	0.0	--	--	--	0.0	4.5
	2	51.8	3.2	--	--	--	3.2	.
	3	15.7	27.1	--	--	--	27.1	19.5
	4	2.9	17.4	--	--	--	17.4	7.7
	5	0.5	24.8	--	--	--	24.8	8.5
	6	20.4	19.8	--	--	--	19.8	20.2
	7+	2.0	7.8	--	--	--	7.8	3.9
Total		100.0	100.0	--	--	--	100.0	100.0
4	1	13.0	--	--	0.0	0.0	0.0	6.2
	2	41.2	--	--	0.0	2.2	1.7	20.6
	3	16.5	--	--	17.1	37.8	33.0	25.1
	4	1.9	--	--	16.5	14.4	14.9	8.7
	5	2.1	--	--	28.6	11.1	15.2	8.9
	6	19.1	--	--	21.0	31.1	28.8	24.1
	7+	6.2	--	--	16.7	3.3	6.4	6.3
Total		100.0	--	--	100.0	100.0	100.0	100.0
All	1	2.9	0.0	0.0	0.0	0.0	0.0	1.9
	2	27.2	3.4	2.8	0.0	2.2	3.2	18.5
	3	22.3	29.5	20.3	17.1	37.8	29.2	24.8
	4	5.6	15.4	17.4	16.5	14.4	15.5	9.2
	5	2.2	17.3	9.8	28.6	11.1	16.7	7.5
	6	36.3	22.0	38.1	21.0	31.1	23.4	31.7
	7+	3.4	12.4	11.6	16.7	3.3	12.0	6.5
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 7. Annual mean age (years) of Lake Erie walleye by gear, management unit, and agency from 2011 to 2021. Means include data from 1975 to 2020.

Year	Sport Fishery															Commercial Fishery					All Gears Total	
	Unit 1				Unit 2			Unit 3			Units 4 & 5					Total	Unit 1	Unit 2	Unit 3	Unit 4		Total
	OH	MI	ON	Total	OH	ON	Total	OH	ON	Total	ON	PA	NY	Total	ON		ON	ON	ON			
2011	5.98	4.35	--	5.68	7.79	--	7.79	8.03	--	8.03	--	8.40	7.76	8.13	6.74	4.86	5.26	6.73	8.33	5.31	5.78	
2012	4.97	4.46	--	4.91	5.78	--	5.78	8.13	--	8.13	--	8.92	7.65	8.35	5.60	4.86	5.33	7.15	7.25	5.34	5.47	
2013	5.16	4.26	--	5.10	6.91	--	6.91	8.09	--	8.09	--	8.79	8.13	8.55	5.95	4.91	4.64	7.09	7.36	5.24	5.60	
2014	5.79	6.05	--	5.80	7.13	--	7.13	8.30	--	8.30	--	8.29	8.00	8.17	6.57	5.26	5.80	8.29	8.35	6.02	6.31	
2015	6.23	5.85	--	6.20	6.88	--	6.88	8.73	--	8.73	--	7.43	8.29	7.89	6.74	4.57	6.30	8.58	8.08	6.14	6.42	
2016	5.17	4.98	--	5.15	5.46	--	5.46	6.91	--	6.91	--	7.48	8.06	7.83	5.68	3.25	4.07	4.97	8.69	4.07	4.61	
2017	4.54	4.39	--	4.52	3.52	--	3.52	3.67	--	3.67	--	4.17	5.68	4.63	4.14	2.90	2.65	2.86	5.86	2.93	3.32	
2018	3.91	3.73	--	3.88	3.56	--	3.56	3.95	--	3.95	--	4.09	4.92	4.35	3.88	3.25	3.18	3.18	4.19	3.28	3.53	
2019	4.36	4.12	--	4.33	4.37	--	4.37	4.53	--	4.53	--	4.70	5.10	4.82	4.45	3.82	3.99	3.86	4.29	3.91	4.17	
2020	NA	NA	--	--	NA	--	--	NA	--	--	--	4.95	6.05	5.27	NA	3.83	4.11	4.12	3.63	3.94	NA	
2021	5.05	5.16	--	5.06	4.54	--	4.54	4.65	--	4.65	--	4.589	5.99	4.91	4.85	4.21	4.32	3.11	3.38	4.05	4.34	
Mean	4.21	3.89	3.66	4.16	4.49	6.58	4.50	5.48	6.72	5.50	8.07	6.57	7.32	6.88	4.44	3.60	3.85	4.89	6.67	3.83	4.08	

Table 8. Estimated abundance at age, survival (S), fishing mortality (F) and exploitation (u) for Lake Erie walleye, 1986-2022 (from ADMB 2022 catch at age analysis recruitment integrated model, M=0.32).

Year	Age							Total	Ages 2+		
	2	3	4	5	6	7+	S		F	u	
1986	24,555,400	4,359,490	35,023,400	2,769,190	2,802,710	1,550,100	71,060,290	0.637	0.130	0.105	
1987	23,743,300	16,543,800	2,727,360	21,618,200	1,716,180	2,693,720	69,042,560	0.642	0.124	0.100	
1988	56,001,500	16,022,000	10,400,300	1,690,740	13,464,800	2,728,190	100,307,530	0.640	0.127	0.102	
1989	11,589,900	37,224,000	9,792,370	6,249,880	1,025,930	9,864,810	75,746,890	0.635	0.134	0.108	
1990	10,146,000	7,831,420	23,453,400	6,092,500	3,923,880	6,786,050	58,233,250	0.642	0.123	0.100	
1991	5,199,730	6,909,200	4,986,420	14,806,200	3,876,740	6,804,330	42,582,620	0.652	0.108	0.088	
1992	16,629,800	3,577,130	4,477,810	3,213,200	9,588,890	6,906,780	44,393,610	0.647	0.116	0.094	
1993	22,281,500	11,275,100	2,249,470	2,795,130	2,020,150	10,378,300	50,999,650	0.623	0.154	0.123	
1994	3,584,980	14,715,600	6,684,910	1,323,370	1,662,860	7,364,350	35,336,070	0.611	0.172	0.136	
1995	18,492,400	2,390,450	8,883,440	4,015,040	804,857	5,503,960	40,090,147	0.618	0.162	0.128	
1996	21,050,700	12,143,400	1,389,920	5,146,920	2,360,280	3,726,180	45,817,400	0.595	0.199	0.155	
1997	2,417,510	13,496,200	6,706,420	763,611	2,879,050	3,424,580	29,687,371	0.584	0.217	0.168	
1998	21,921,300	1,580,340	7,784,800	3,849,060	444,638	3,686,570	39,266,708	0.598	0.194	0.152	
1999	10,710,600	13,974,400	860,596	4,220,010	2,126,550	2,296,770	34,188,926	0.612	0.171	0.135	
2000	9,919,340	7,065,210	8,208,130	503,845	2,507,870	2,643,660	30,848,055	0.624	0.152	0.121	
2001	30,913,600	6,611,850	4,247,290	4,920,890	306,526	3,152,530	50,152,686	0.676	0.072	0.059	
2002	3,580,560	21,346,900	4,315,280	2,759,270	3,215,190	2,255,790	37,472,990	0.675	0.073	0.061	
2003	24,525,800	2,506,060	14,342,700	2,889,560	1,857,520	3,687,730	49,809,370	0.684	0.060	0.050	
2004	359,575	17,152,600	1,681,030	9,584,530	1,938,310	3,716,480	34,432,525	0.682	0.063	0.052	
2005	104,182,000	256,161	11,692,700	1,142,050	6,532,540	3,851,120	127,656,571	0.701	0.036	0.030	
2006	3,434,520	73,639,100	172,188	7,848,660	770,410	7,017,420	92,882,298	0.673	0.076	0.063	
2007	7,013,940	2,433,150	49,453,200	115,243	5,275,720	5,228,390	69,519,643	0.674	0.075	0.062	
2008	1,876,750	4,980,920	1,636,680	33,103,200	77,346	7,042,260	48,717,156	0.679	0.067	0.056	
2009	17,907,800	1,332,660	3,373,350	1,105,380	22,446,900	4,822,950	50,989,040	0.692	0.048	0.040	
2010	6,549,800	12,749,200	907,437	2,289,540	752,585	18,592,000	41,840,562	0.689	0.053	0.044	
2011	6,632,380	4,678,070	8,745,160	620,168	1,567,800	13,199,600	35,443,178	0.689	0.052	0.044	
2012	11,090,100	4,718,020	3,196,340	5,965,600	424,694	10,118,300	35,513,054	0.673	0.076	0.063	
2013	8,268,490	7,804,080	3,109,530	2,099,000	3,938,820	6,953,070	32,172,990	0.667	0.084	0.069	
2014	4,062,670	5,822,140	5,122,080	2,029,870	1,375,590	7,124,230	25,536,580	0.641	0.124	0.100	
2015	6,114,820	2,828,200	3,689,100	3,223,480	1,283,990	5,351,840	22,491,430	0.642	0.123	0.100	
2016	21,319,600	4,234,890	1,767,250	2,289,590	2,013,740	4,131,790	35,756,860	0.669	0.081	0.067	
2017	81,649,500	14,817,200	2,677,530	1,110,590	1,448,280	3,882,310	105,585,410	0.687	0.056	0.047	
2018	7,722,500	57,094,500	9,548,940	1,716,350	715,543	3,427,490	80,225,323	0.663	0.090	0.074	
2019	10,076,600	5,440,570	37,648,700	6,268,790	1,131,790	2,726,200	63,292,650	0.658	0.098	0.080	
2020	26,244,300	7,087,350	3,552,100	24,431,500	4,083,800	2,505,470	67,904,520	0.661	0.094	0.077	
2021	38,233,200	18,300,900	4,523,620	2,253,830	15,596,300	4,210,820	83,118,670	0.658	0.099	0.081	
2022	21,084,700	26,480,200	11,473,100	2,819,490	1,415,400	12,476,500	75,749,390				

Table 9. Estimated harvest of Lake Erie walleye for 2022, and population projection for 2023 when fishing with 60% F_{msy} . The 2022 and 2023 projected spawning stock biomass values are from the ADMB-2022 recruitment-integrated model. The range in the RAH was calculated using \pm one standard deviation from the mean RAH.

SSB₀= 62.350 million kilograms
 20% SSB₀= 12.470 million kilograms
 F_{msy} = 0.557

Age	2022 Stock Size (millions of fish)		60% F_{msy}	Rate Functions			2022 RAH (millions of fish)			Projected 2023 Stock Size (millions)	
	Mean	F		Sel(age)	(F)	(S)	(u)	Min.	Mean	Max.	Mean
2	21.085			0.274	0.091	0.663	0.075	1.170	1.580	1.990	59.002
3	26.480			0.933	0.312	0.532	0.231	4.894	6.119	7.344	13.973
4	11.473			0.990	0.331	0.522	0.243	2.220	2.790	3.360	14.079
5	2.819			0.950	0.317	0.529	0.235	0.519	0.662	0.804	5.984
6	1.415			0.916	0.306	0.535	0.228	0.251	0.322	0.393	1.491
7+	12.477			1.000	0.334	0.520	0.245	2.443	3.060	3.677	7.243
Total (2+)	75.749		0.334				0.192	11.498	14.533	17.568	101.772
Total (3+)	54.665							10.328	12.953	15.578	42.770
SSB	73.575	mil. kgs									65.047 mil. kgs
probability of 2023 spawning stock biomass being less than 20% SSB ₀ = 0.000%											

Table 10. Western basin age 0 walleye recruitment index observed in bottom trawls by the Ontario Ministry of Natural Resources (ONT) and Ohio Department of Natural Resources (OH) between 2000 and 2021.

Year Class	Year of Recruitment to Fisheries	OH+ONT Trawl Age-0 CPHa
2000	2002	4.113
2001	2003	28.499
2002	2004	0.139
2003	2005	183.015
2004	2006	5.402
2005	2007	12.665
2006	2008	2.051
2007	2009	25.408
2008	2010	7.238
2009	2011	7.107
2010	2012	26.260
2011	2013	6.502
2012	2014	6.417
2013	2015	10.584
2014	2016	29.050
2015	2017	84.105
2016	2018	9.224
2017	2019	22.852
2018	2020	255.581
2019	2021	225.310
2020	2022	97.480
2021	2023	345.599

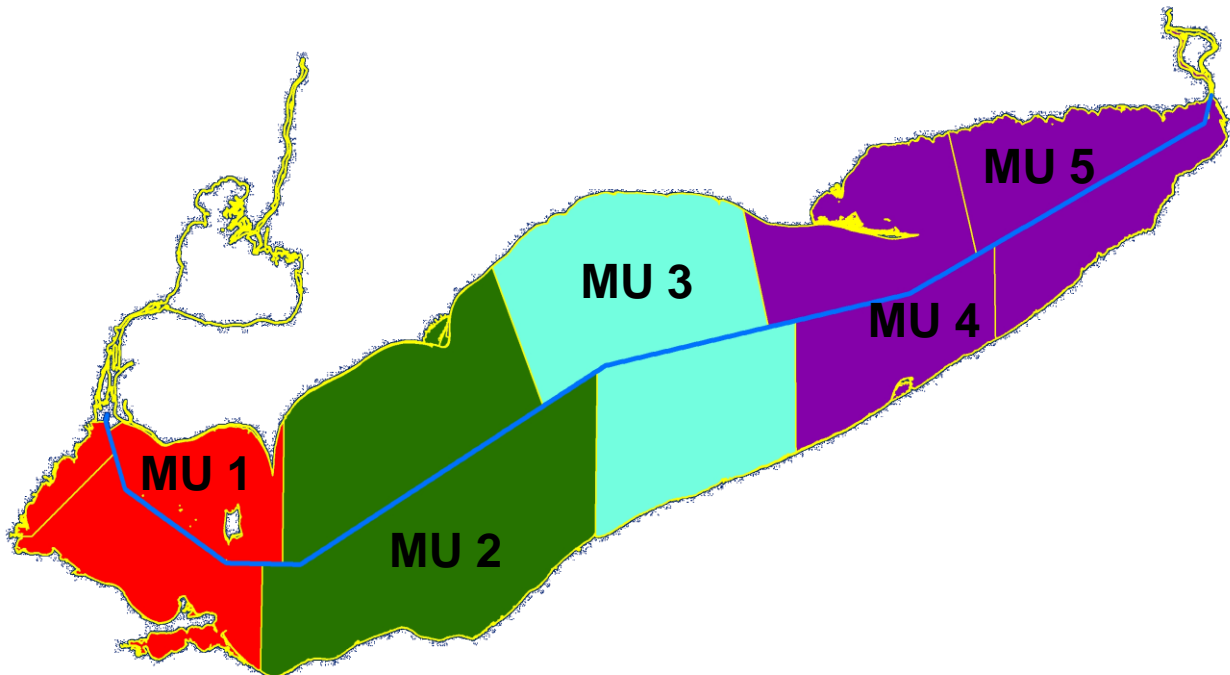


Figure 1. Map of Lake Erie with management units (MU) recognized by the Walleye Task Group for interagency management of Walleye.

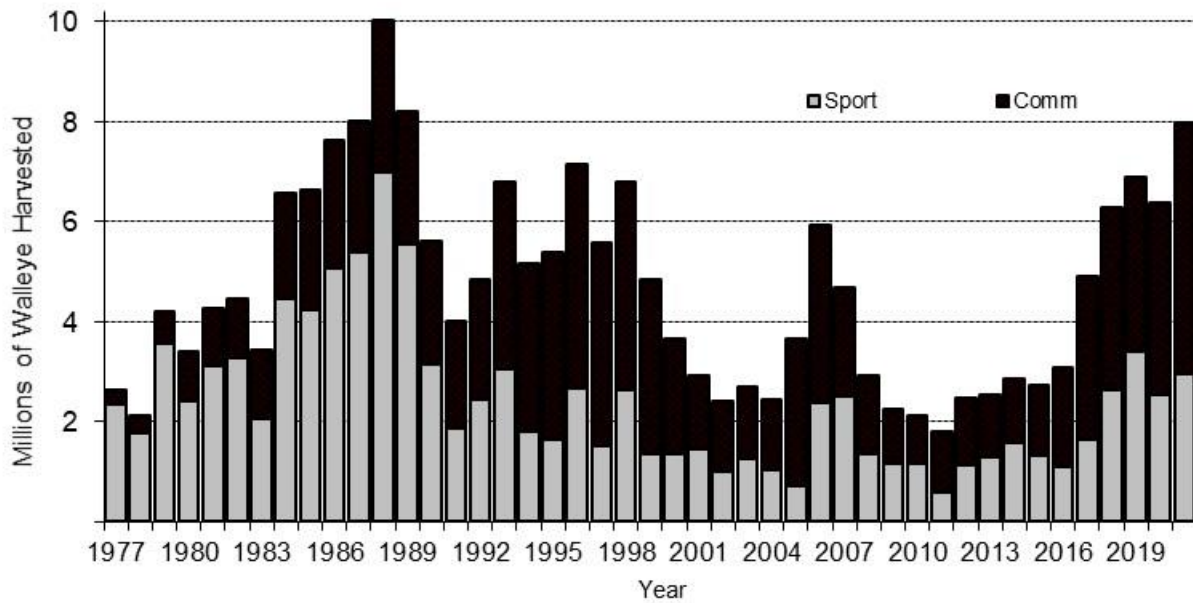


Figure 2. Lake-wide harvest of Lake Erie Walleye by sport and commercial fisheries during 1977-2021.

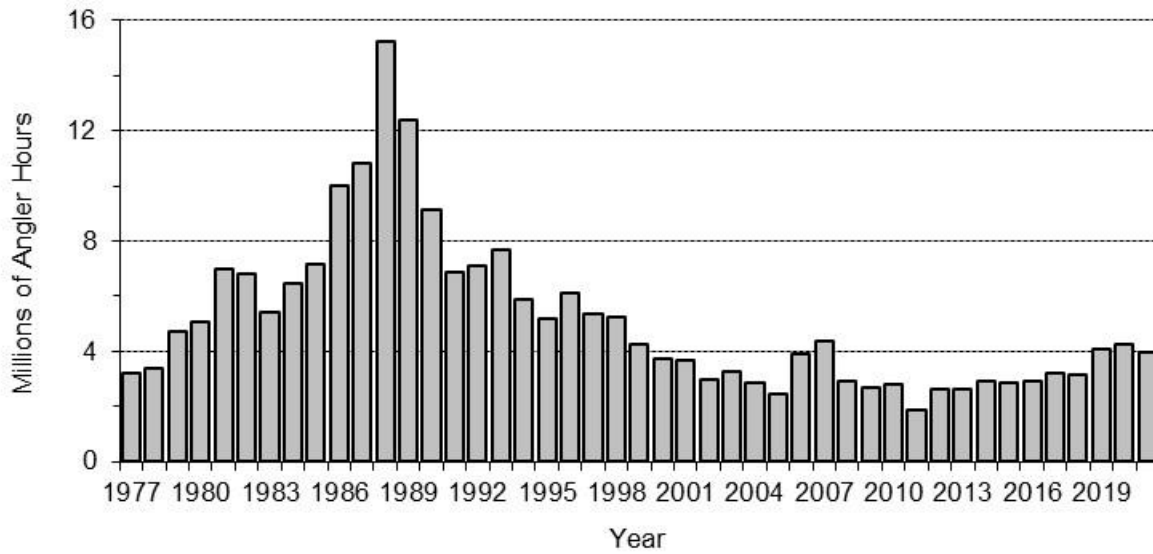


Figure 3. Lake-wide total effort (angler hours) by sport fisheries for Lake Erie Walleye during 1977-2021.

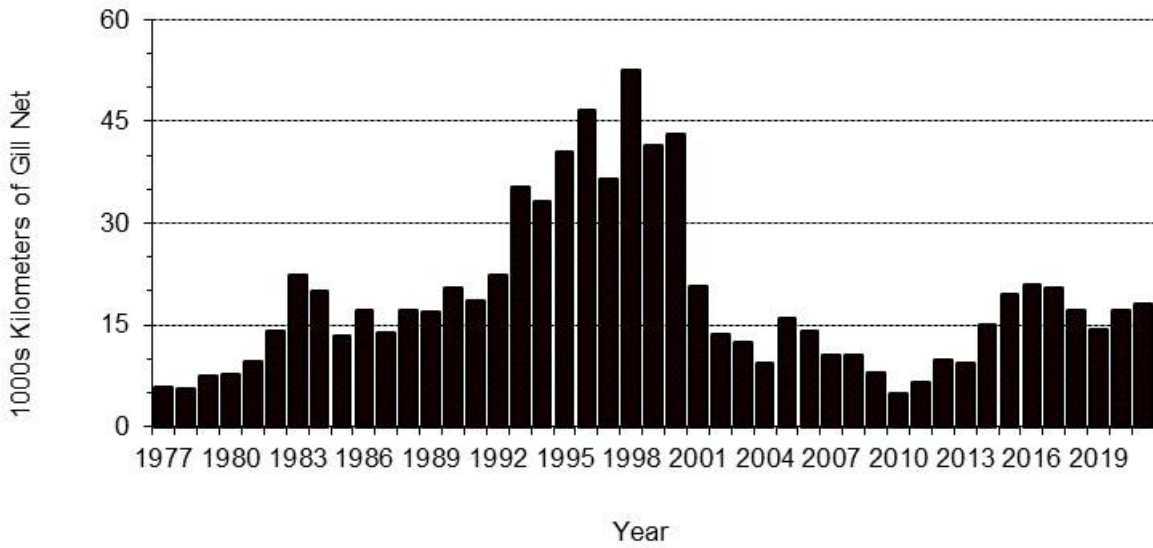


Figure 4. Lake-wide total effort (thousand kilometers of gill net) by commercial fisheries for Lake Erie Walleye during 1977-2021.

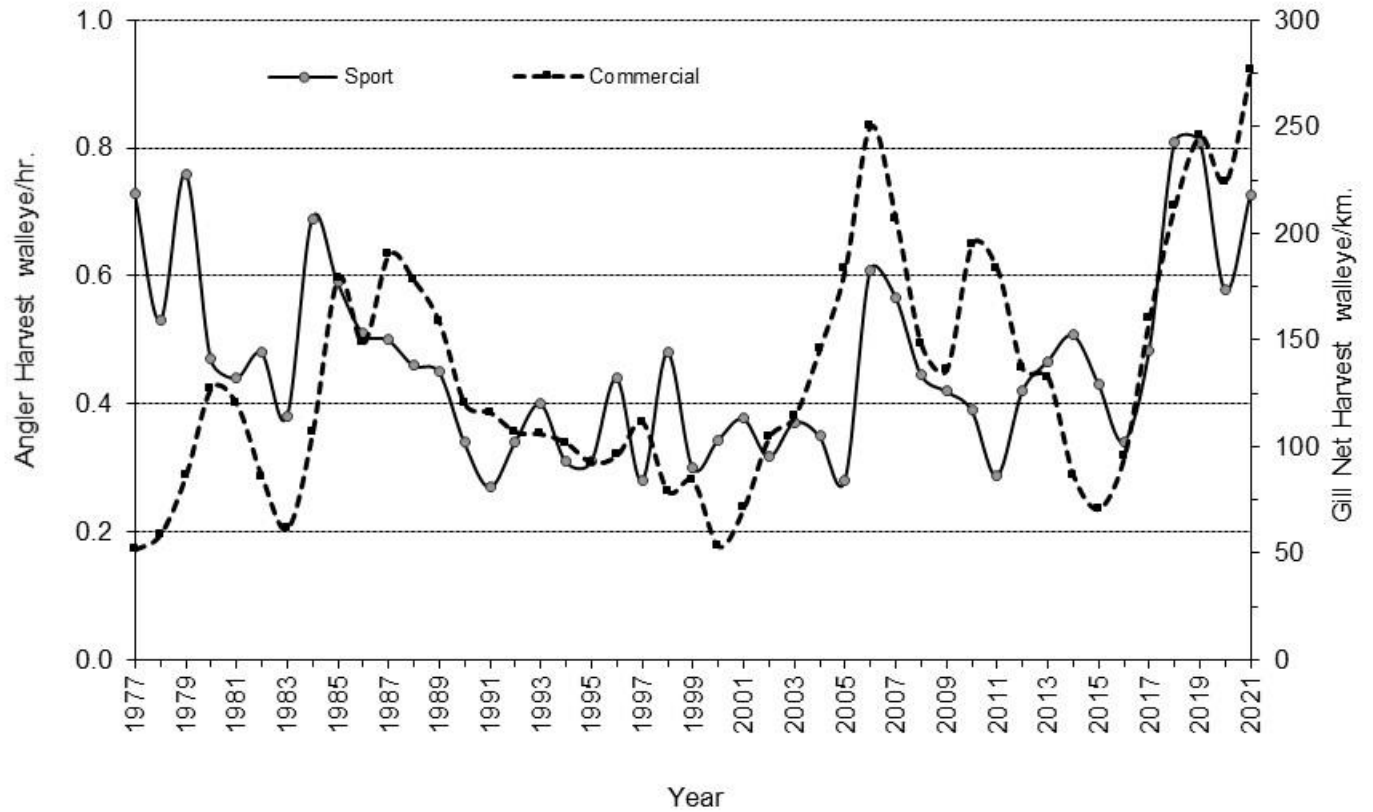


Figure 5. Lake-wide harvest per unit effort (HPE) for Lake Erie sport and commercial Walleye fisheries during 1977-2021.

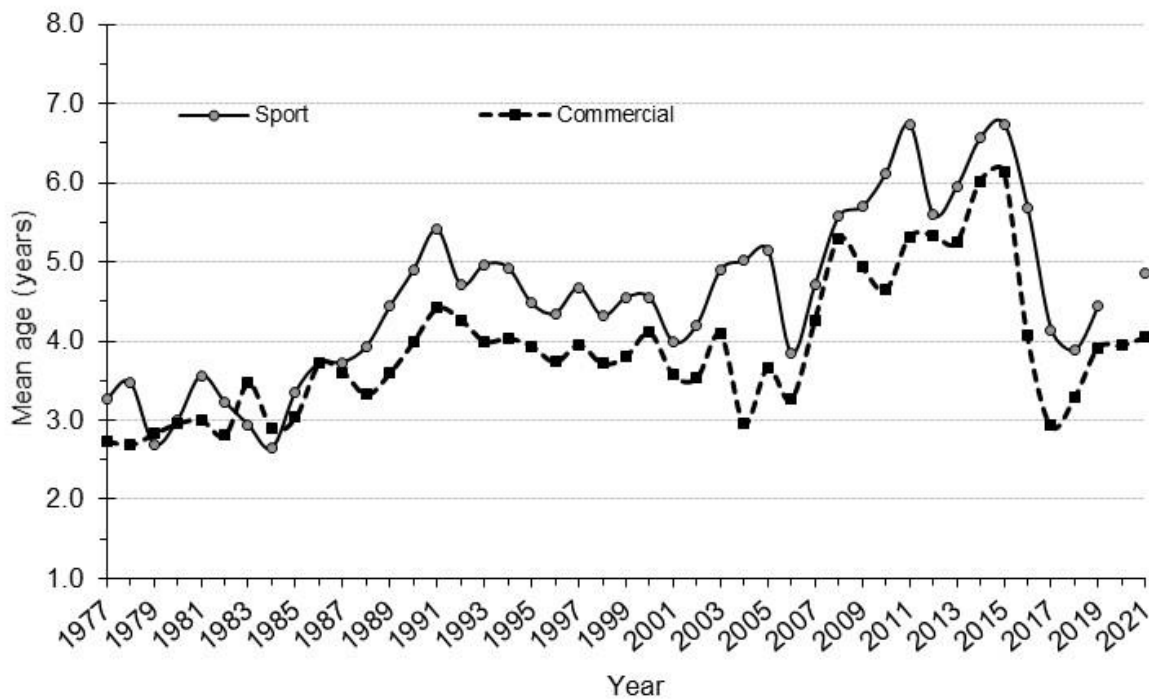


Figure 6. Lake-wide mean age of Lake Erie Walleye in sport and commercial harvests during 1977-2021.

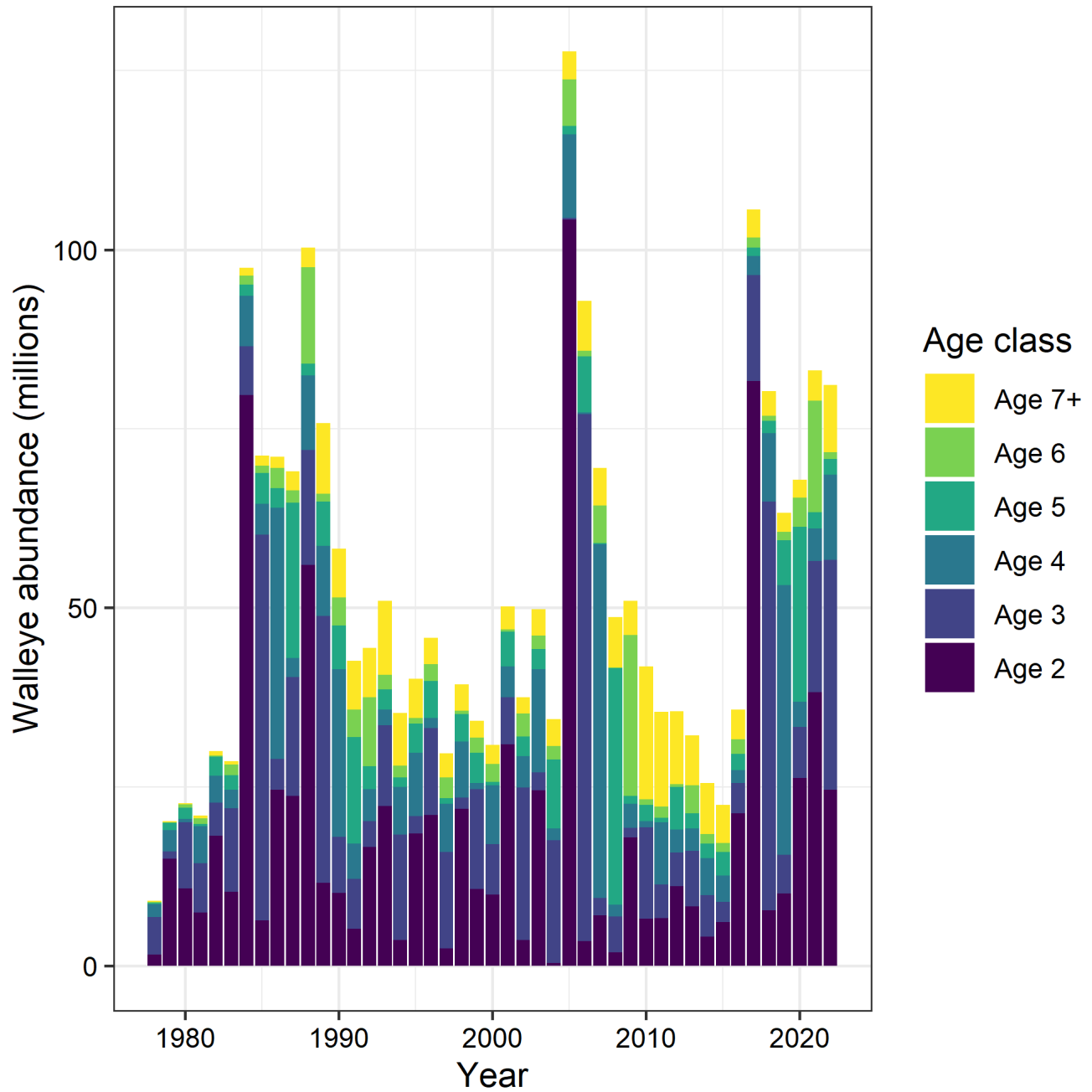


Figure 7. Abundance at age for age-2 and older Walleye in Lake Erie's west and central basins during 1978-2021 and the 2022 projection, estimated from the ADMB model. Data shown are from Table 8.

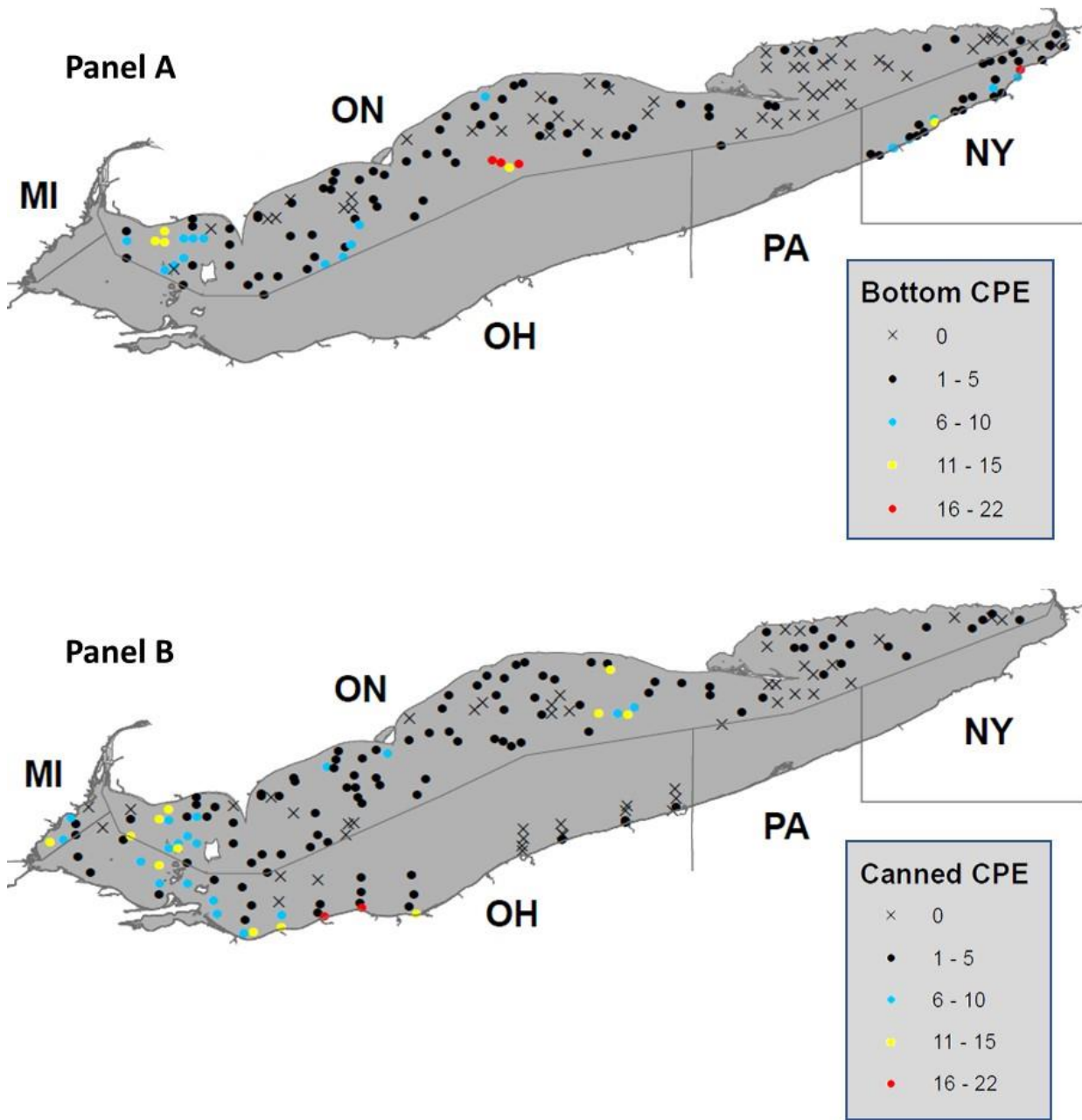


Figure 8. Relative abundance of yearling Walleye captured in bottom-set (Panel A) and suspended or keged (canned) multifilament (Panel B) gillnets from Michigan, and monofilament gillnets from Ohio, New York, and Ontario waters in 2021. Catches have been adjusted to reflect panel length (standardized to 50 ft panels) and differences in the presence of large mesh (>5.5" excluded).

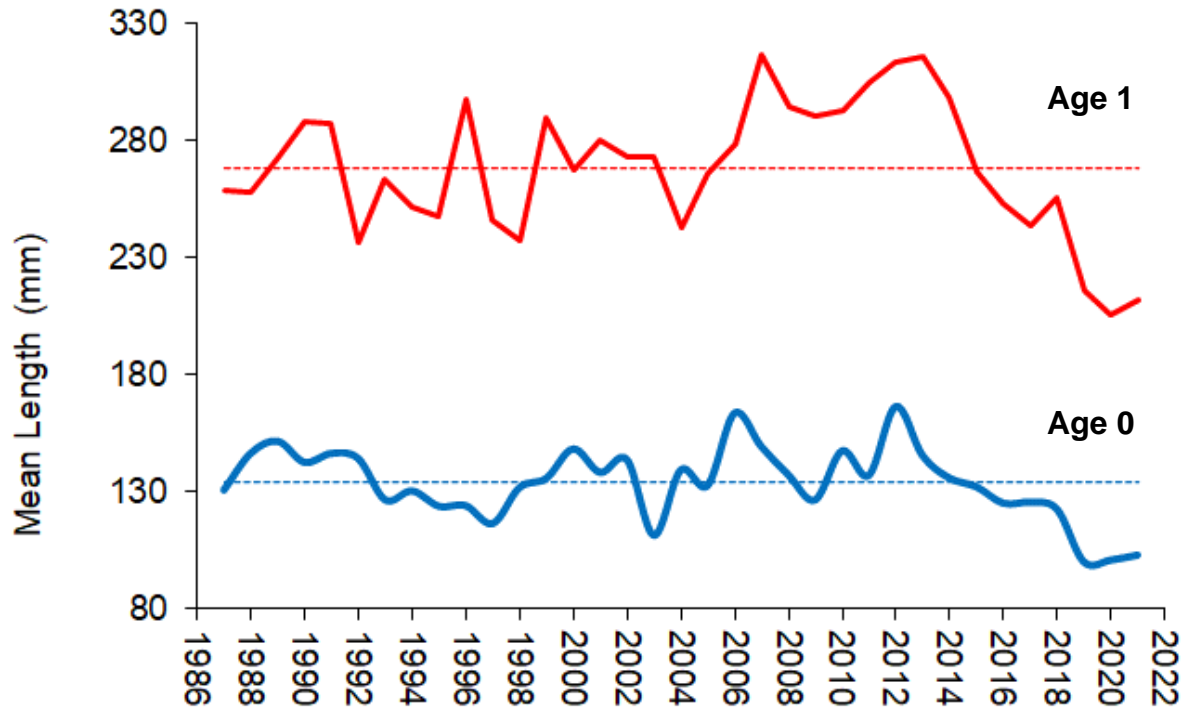


Figure 9. Annual mean total length of age 0 and 1 Walleye in Ohio and Ontario waters of western Lake Erie 1987-2021. Means across years (1987-2021) are presented as dashed lines for each age group.

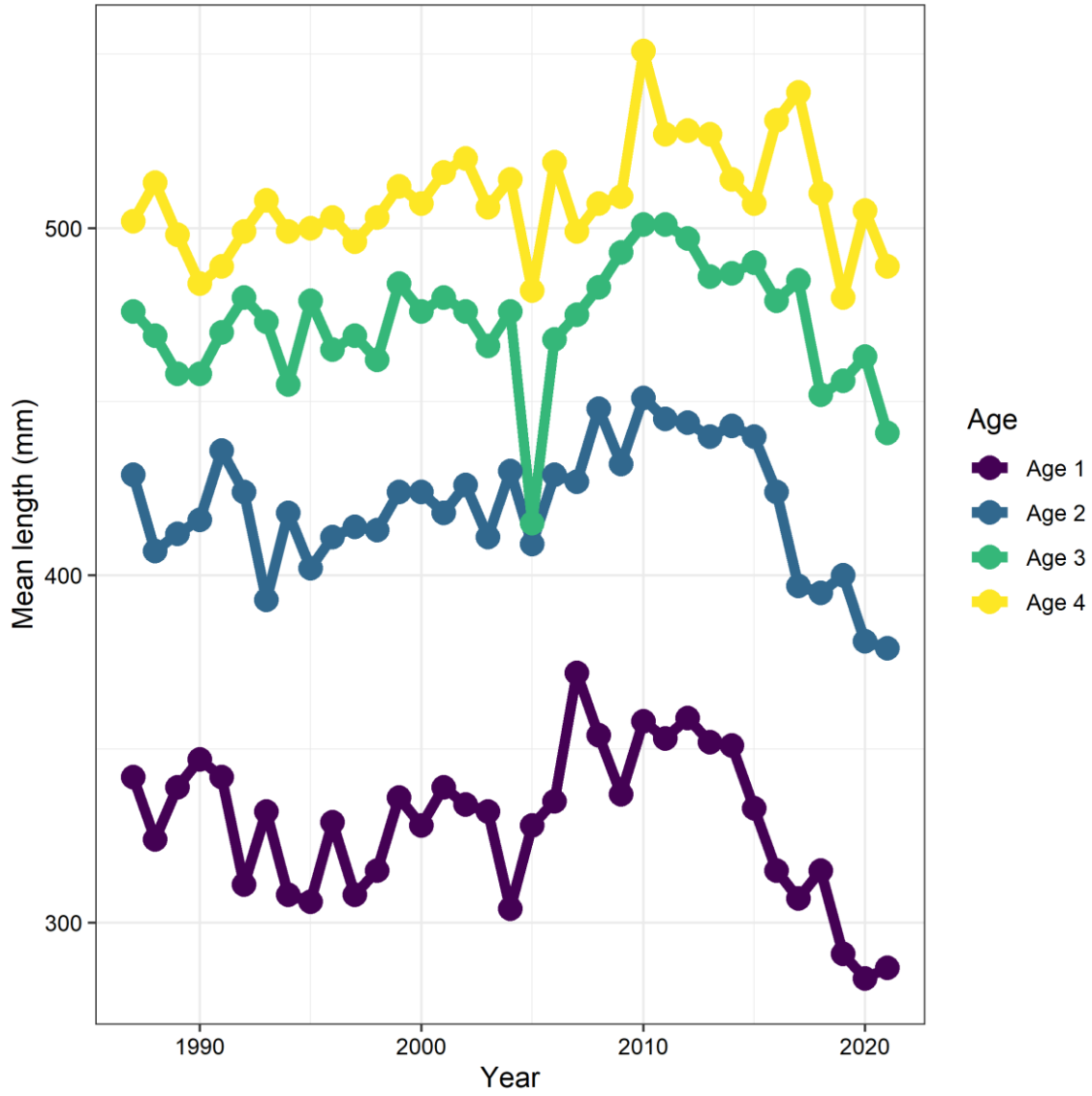


Figure 10. Mean lengths of age 1 through age 4 Walleye sampled in Ohio and Ontario waters of Lake Erie during 1987-2021. Data shown for the TAC area (i.e., MUs 1-3).