Report of the Lake Erie Yellow Perch Task Group

March 29th, 2019

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Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

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Note: The data and management summaries contained in this report are provisional. Every effort has been made to ensure their accuracy. Contact individual agencies for complete state and provincial data. Data reported in pounds for years before 1996 have been converted from metric tonnes. Please contact the Yellow Perch Task Group or individual agencies before using or citing data published herein.

Introduction

From April 2018 through March 2019 the Yellow Perch Task Group (YPTG) addressed the following charges:

1. Maintain and update the centralized time series of datasets required for population models and assessment including:
   a. Fishery harvest, effort, age composition, biological and stock parameters.
   b. Survey indices of young of year, juvenile and adult abundance, size at age and biological parameters.
   c. Fishing harvest and effort by grid.

2. Report Recommended Allowable Harvest (RAH) levels for 2019.

3. Participate in the LEPMAG yellow perch harvest strategy evaluation process by assisting the STC with the development of new catch-at-age models and exploitation strategies for yellow perch, leading to the development of a Yellow Perch Management Plan.

4. Improve existing population models to produce the most scientifically defensible and reliable method for estimating and forecasting abundance, recruitment, and mortality.
   a. Examine available recruitment indices for incorporation into catch-at-age model.

Charge 1: 2018 Fisheries Review and Population Dynamics

The lakewide total allowable catch (TAC) of Yellow Perch in 2018 was 10.498 million pounds. This allocation represented a 1% increase from a TAC of 10.375 million pounds in 2017. For Yellow Perch assessment and allocation, Lake Erie is partitioned into four management units (MUs; Figure 1.1). The 2018 TAC allocation was 3.031, 3.237, 3.776, and 0.454 million pounds for MUs 1 through 4, respectively. In March 2018, the process of developing a new assessment model (PR model), management strategy evaluation, and harvest policy for Lake Erie Yellow Perch was underway, but not yet complete. Therefore, the Lake Erie Committee (LEC) set 2018 TACs after considering abundance estimates and RAH ranges from two assessment models that were presented by the YPTG (YPTG and PR models; YPTG 2018), with the TACs remaining as close to the previous year's value as possible while remaining within the RAH range estimated using the PR model. For MU1, the LEC set the TAC equal to the maximum RAH estimated by the PR model (3.031 million pounds). For MU2 and MU3, the LEC set the TAC at 3.237 and 3.776

million pounds respectively, which was equal to the 2017 TAC. For MU4, the LEC set the TAC at 0.454 million pounds, which represented a 51% increase from the 2017 TAC.

The lake-wide harvest of Yellow Perch in 2018 was 6.782 million pounds, or 65% of the total 2018 TAC. This was a 13% decrease from the 2017 harvest of 7.789 million pounds. Harvest from MUs 1 through 4 was 2.326, 1.830, 2.323, and 0.303 million pounds, respectively (Table 1.1). The portion of TAC harvested was 77%, 57%, 62%, and 67%, in MUs 1 through 4, respectively. In 2018, Ontario harvested 4.614 million pounds, followed by Ohio (1.976 million lbs.), Michigan (0.108 million lbs.), Pennsylvania (0.056 million lbs.), and New York (0.029 million lbs.).

Ontario's fraction of allocation harvested was 103% in MU1, 86% in MU2, 92% in MU3, and 104% in MU4 (see paragraph below regarding Ontario's harvest reporting and commercial ice allowance policy). Ohio fishers attained 63% of their TAC in the western basin (MU1), 32% in the west central basin (MU2), and 38% in the east central basin (MU3). Michigan anglers in MU1 attained 39% of their TAC. Pennsylvania fisheries harvested 9% of their TAC in MU3 and 3% of their TAC in MU4. New York fisheries attained 21% of their TAC in MU4. Ontario's portion of the lakewide Yellow Perch harvest in 2018 (68%) was comparable to 2017 (64%; Table 1.1). Ohio's proportion of lakewide harvest in 2018 (30%) was also similar to 2017, and harvest in Michigan, Pennsylvania, and New York waters combined represented 3% of the lakewide harvest in 2018.

Ontario continued to employ a commercial ice allowance policy implemented in 2002, by which 3.3% is subtracted from commercial landed weight. This step was taken so that ice was not debited towards fishers' quotas. Ontario's landed weights in the YPTG report have not been adjusted to account for ice content. Ontario's reported Yellow Perch harvest in tables and figures is represented exclusively by the commercial gill net fishery. Yellow Perch sport harvest from Ontario waters is assessed periodically, which last occurred in 2014, but is not reported here. Reported sport harvests for Michigan, Ohio, Pennsylvania, and New York are based on creel survey estimates. Ohio, Pennsylvania, and New York trap net harvest and effort are based on commercial catch reports of landed fish. Additional fishery documentation is available in annual agency reports.

Harvest, fishing effort, and fishery harvest rates are summarized from 2009 to 2018 by management unit, year, agency, and gear type in Tables 1.2 to 1.5. Trends across a longer time series (1975 to 2018) are depicted graphically for harvest (Figure 1.2), fishing effort (Figure 1.3), and harvest rates (Figure 1.4) by management unit and gear type. The spatial distributions of

harvest (all gears) and effort by gear type for 2018 in ten-minute interagency grids are presented in Figures 1.5 through 1.8.

Ontario's Yellow Perch harvest from large mesh (3 inches or greater stretched mesh) gill nets in 2018 was 1%, 5%, and 4% of the gill net harvest in management units 1, 2 and 3, respectively, and was negligible (0.2%) in MU4. Harvest, effort, and catch per unit effort from (1) small mesh Yellow Perch effort (<3 inch stretched mesh) and (2) larger mesh sizes, are distinguished in Tables 1.2 to 1.5. Harvest from targeted small mesh gill nets in 2018 increased 53% in MU4, but declined by 2% in MU1, 16% in MU2, and 11% in MU3. Ontario trap net harvest was minimal (156 pounds in 2018) and is included in the total harvest of Yellow Perch in MU1 (Tables 1.1 and 1.2). Ontario commercial Rainbow Smelt trawlers incidentally catch Yellow Perch in management units 2, 3 and 4, and this harvest is included in Tables 1.3 to 1.5. In 2018, 259 pounds of Yellow Perch were harvested in trawl nets in MU3, and 355 pounds were harvested in MU4.

Targeted (i.e., small mesh) gill net effort in 2018 decreased from 2017 in MU1 and MU2 (-9%, and -2%, respectively), but increased in MU3 and MU4 (+9%, and +57%, respectively). Targeted gill net harvest rates in 2018 increased relative to 2017 rates by 8% in MU1, and decreased by 14% in MU2, 19% in MU3, and 2% in MU4 (Figure 1.4).

In 2018, sport harvest in U.S. waters decreased in all management units, by 40% in MU1, 42% in MU2, 79% in MU3, and 54% in MU4 compared to the 2017 harvest (Figure 1.2). Similarly, angling effort in U.S. waters decreased in 2018 from 2017, in all management units, by 35%, 62%, 84%, and 41% in MU1, MU2, MU3, and MU4 respectively (Figure 1.3). In 2018, angling effort in U.S. waters was at its lowest in the time series in MU2 and MU3 (Figure 1.3)

Sport fishing harvest rates are commonly expressed as fish harvested per angler hour for those seeking Yellow Perch. These harvest rates are presented in Tables 1.2 to 1.5. Compared to 2017 rates, harvest per angler hour decreased in Michigan (-47%) and Ohio waters of MU1 (-11%), and Pennsylvania waters of MU3 (-85%) and MU4 (-72%). Harvest rates increased in the in Ohio waters of MU2 (+21%) and MU3 (+34%), and New York waters of MU4 (+13%).

Angler harvest rates in kilograms per angler hour are presented graphically in Figure 1.4 for each management unit by pooling jurisdictions' harvest weights and effort. In 2018, the sport harvest rate (in kg/hr) decreased in MU1 (0.44; -9%), and MU4 (0.39; -22%), but increased in MU2 (0.31; +52%) and MU3 (0.45; +35%), from 2017 rates. Differences between harvest rates

reported in fish per angler hour and kg per angler hour reflect the influence of size and age composition on harvest rates.

Trap net harvest decreased in all management units, by 2% in MU1, 11% in MU2, 1% in MU3, and 14% in MU4. Compared to 2017, trap net effort (lifts) in 2018 decreased by 9% in MU1, decreased in MU2 by 40%, increased by 32% in MU3, and decreased by 35% in MU4. Trap net harvest rates increased in MU1 (+8%), MU2 (+48%), and MU4 (+33%), and decreased in MU3 (-25%).

Age Composition and Growth

Lakewide, age-4 fish contributed the most to the Yellow Perch harvest (51%), followed by age-3 fish (24%), with age-2 and age-6-and-older fish contributing roughly equally (10 and 9%, respectively; Table 1.6). In MU1, age-4 fish (2014 year class, 50%), and age-3 fish (2015 year class, 31%) contributed most to the fishery. In MU2, age-4 fish (2014 year class, 57%) and age-3 fish (2015 year class, 27%) contributed most to the fishery. In MU3, age-4 fish (2014 year class, 52%) and age-6-and-older fish (2012 year class and older, 21%) contributed the most to the harvest. In MU4, age-2 fish (2016 year class, 51%) and age-3 fish (2015 year class, 27%) contributed the most to the harvest.

The task group continues to update Yellow Perch growth data in: (1) weight-at-age values recorded annually in the harvest and (2) length- and weight-at-age values taken from interagency trawl and gill net surveys. These values are applied in the calculation of population biomass and the forecasting of harvest in the approaching year. Therefore, changes in weight-at-age factor into the changes in overall population biomass and determination of recommended allowable harvest (RAH).

Statistical Catch-at-Age Analysis

Population size for each management unit was estimated by statistical catch-at-age analysis (SCAA) using the Auto Differentiation Model Builder (ADMB) computer program (Fournier et al. 2012). In 2019, the YPTG used the ADMB model developed by the Quantitative Fisheries Centre (QFC) at Michigan State University (hereafter referred to as the Peterson-Reilly or PR model) as part of the ongoing Lake Erie Percid Management Advisory Group (LEPMAG) review of Yellow Perch management on Lake Erie.

The PR model uses harvest and effort data from commercial gill net, commercial trap net, and recreational fisheries. Survey catch at age of age-2 and older fish from gill net and trawl surveys are also incorporated. In addition, age-0 and age-1 recruitment data are incorporated into the model as a recruitment index. The PR model estimates selectivity for all ages in the fisheries and surveys. There is a commercial gill net selectivity block beginning in 1998. Catchabilities for all fisheries and surveys vary annually as a random walk. The model is fit to total catch and proportions-at-age (multinomial age composition) as separate data sets.

Running the PR model is a three-step process. In the first step, an ADMB model without recruitment data is run iteratively until the maximum effective sample size for the multinomial age composition stabilizes (i.e., does not change by more than 1-2 units). Second, age-2 abundance estimates from the first model are added to age-0 and age-1 recruitment data in a multi-model inference (MMI) R-based model to determine parameters for estimating recruitment. Recruitment data from the last nine years are removed from the model to minimize possible retrospective effects. Further, years with missing data in one or more data sets are removed from all data sets. Surveys missing data for the projection year (e.g., 2017 year class in the 2019 TAC year) are also removed from the analysis. A list of all possible non-redundant models is generated from the survey data and fit using the R-based glmulti package (Calcagno 2013). All models falling within 2 AIC units of the best model are used to generate the model-averaged coefficients. Surveys are not weighted equally in the models; the surveys that are more highly correlated with ADMB age-2 estimates are weighted more heavily, and have greater influence on the recruitment predictions. Parameter estimates for the model-averaged coefficients for each MU are detailed in Appendix Table 2. A recruitment index is generated to estimate age-2 fish for each year class available in the recruitment data, using the age-0 and age-1 survey data. This process is repeated using just age-0 data, which is only used to estimate recruitment in two years' time. Data from trawl and gill net index recruitment series for the time period examined are presented in Appendix Table 3, and a key that summarizes abbreviations used for the trawl and gill net series is presented in Appendix Table 4.

In the third step, the recruitment index is added to the ADMB model, and this data set is used to inform age-2 abundance estimates within the objective function. This model is then run iteratively until the maximum effective sample size for the multinomial age composition stabilizes.

Estimates of population size, from 2000 to 2018, and projections for 2019, are presented in Table 1.7. Abundance, biomass, survival, and exploitation rates are presented by management unit graphically for 1975 to 2018 in Figures 1.9 to 1.12. Mean weights-at-age from assessment surveys were applied to abundance estimates to generate population biomass estimates (Figure 1.10). Population abundance and biomass estimates are critical to monitoring the status of stocks and determining recommended allowable harvest.

Abundance estimates should be interpreted with several caveats. Inclusion of abundance estimates from 1975 to 2018 implies that the time series are continuous. Lack of data continuity for the entire time series weakens the validity of this assumption. Survey data from multiple agencies are represented only in the latter part of the time series (since the late 1980s); methods of fishery data collection have also varied. Some model parameters, such as natural mortality, are constrained to constants. This technique lessens our ability to directly compare abundance levels across three decades. In addition, with SCAA the most recent year's population estimates inherently have the widest error bounds, which is to be expected for cohorts that remain at-large under less than full selectivity in the population.

In the SCAA model, population estimates are derived by minimizing an objective function weighted by data sources, including fishery effort, fishery catch, and survey catch rates. In 2011-2012, the YPTG group determined data weightings (referred to as lambdas in ADMB) using an expert opinion approach for evaluating potential sources of bias in data sets that could negatively influence model performance (YPTG 2012). These data weightings were used during 2019 in both the YPTG and PR models and are presented in Appendix Table 1. The additional recruitment index (generated from the glmulti process) was given a lambda weighting of 1.

2019 Population Size Projection

Stock size estimates for age-2-and-older Yellow Perch in 2019 were estimated by the SCAA model (Table 1.7). Standard errors and ranges for 2019 estimates are provided for each age, and descriptions of minimum, mean, and maximum population estimates refer to the age-specific mean estimates minus or plus one standard deviation (Table 2.2).

Stock size estimates for 2018 (Table 1.7) were lower than those projected last year in MUs 2 and 3, but higher than projected in MUs 1 and 4 (YPTG 2018). Abundance projections for 2019

were 38.237, 45.871, 85.684, and 13.911 million age-2-and-older Yellow Perch in management units 1 through 4, respectively. Abundance estimates of age-2-and-older Yellow Perch in 2019 are projected to decrease by 3% in MU1, 1% in MU2, and 25% in MU4, and increase by 13% in MU3 compared to the 2018 abundance estimates (Table 1.7, Figure 1.9).

Estimates of 2019 age-2 Yellow Perch recruitment (the 2017 year class) were 20.320, 19.691, 42.034, and 2.277 million fish in management units 1 through 4, respectively (Table 1.7.).

Age-3-and-older Yellow Perch abundance in 2019 is projected to be 17.917, 26.180, 43.651, and 11.635 million fish in MUs 1 through 4, respectively. Model estimates of abundance for age-3-and-older Yellow Perch for 2019 are projected to decrease from the 2018 estimates by 38% and 23% in MUs 1 and 2, respectively, and increase by 1% and 90% in MUs 3 and 4, respectively. Lakewide abundance of age-2-and-older Yellow Perch in 2019 is projected to be 183.7 million fish, an increase of 2% from 2018.

As a function of population estimates and mean weight-at-age from fishery-independent surveys, total biomass estimates of age-2-and-older Yellow Perch for 2019 are projected to decrease in MU1 (-19%), MU2 (-18%), and MU3 (-3%), and be approximately the same in MU4 (-0.1%), compared to 2018 estimates (Figure 1.10).

Estimates of Yellow Perch survival for age-3-and-older in 2018 were 40%, 53%, 51%, and 57% in MUs 1 through 4, respectively (Figure 1.11). Estimates of Yellow Perch survival in 2018 for age-2-and-older fish were: 46% in MU1, 57% in MU2, 58% in MU3, and 62% in MU4. Estimated exploitation rates of ages-3-and-older Yellow Perch in 2018 were 34%, 17%, 20%, and 12% in management units 1 through 4, respectively. Estimates of Yellow Perch exploitation for ages-2-and-older fish in 2018 were: 27% in MU1, 13% in MU2, 11% in MU3, and 6% in MU4 (Figure 1.12).

Charge 2: Harvest Strategy and Recommended Allowable Harvest

In 2019 the LEC and LEPMAG determined new harvest control rules for Yellow Perch. These harvest control rules will form the foundation of the Yellow Perch Management Plan for the next 5 years. The harvest control rules are comprised of:

- Target fishing mortality as a percent of the fishing mortality at maximum sustainable yield (F_{msy})
- Limit reference point of the biomass at maximum sustainable yield (B_{msy})
- Probabilistic risk tolerance, P-star, P*=0.05
- A limit on the annual change in TAC of ±20%

Target fishing rates and limit reference points are estimated annually using SCAA model results. Estimating reference points and recommended allowable harvest is a three step process. First, estimated recruitment and spawning stock biomass from the SCAA model, along with maturity, weight, and selectivity at age, are entered in to an ADMB model that estimates the parameters of a Ricker stock-recruitment relationship and the abundance of spawning stock biomass without fishing (SSB_0). The stock-recruitment relationships for management units 1, 2, and 3, are fit using a hierarchical framework, while management unit 4 is fit independently. In the second step, maturity, weight, and selectivity at age, along with the parameters of the stock-recruitment relationship are entered in an R-based model. This model estimates F_{msy} and B_{msy} for the harvest control rule. Finally, F_{msy}, F_{target} (as a percent of F_{msy}), and B_{msy} (as a percent of SSB_0), are entered into the PR ADMB model to estimate RAH in each management unit. If the model estimates that fishing at F_{target} exceeds a 5% probability (P*) that the projected spawning stock biomass will be equal to or less than the limit reference point (B_{msy}), then the fishing rate is reduced until the probability is less than 5%. Values of SSB_0, B_{msy}, F_{msy}, and F_{target} for each management unit can be found in table 2.1. Target fishing rates are applied to population estimates and their standard errors to determine minimum, mean, and maximum RAH values for each management unit (Tables 2.2 and 2.3). In addition, RAH values may be subject to a ±20% limit on the annual change in TAC.

Quota allocation by management unit and jurisdiction for 2019 was determined by the same methods applied in 2009-2018, using GIS applications of jurisdictional surface area of waters within each MU (Figure 2.1). The allocation of shares by management unit and jurisdiction are:

Allocation of TAC within Management Unit and Jurisdiction, 2019:

MU1:	ONT	40.6%	OH	50.3%	MI	9.1%
MU2:	ONT	45.6%	OH	54.4%		
MU3:	ONT	52.3%	OH	32.4%	PA	15.3%
MU4:	ONT	58.0%	NY	31.0%	PA	11.0%

Charge 3: Yellow Perch Management Plan and Lake Erie Percid Management Advisory Group Management Strategy Evaluation

Pursuant to the goal of developing a Yellow Perch Management Plan, the LEC, Standing Technical Committee (STC), Michigan State University Quantitative Fisheries Center (QFC), and stakeholder groups from all Lake Erie jurisdictions formed the Lake Erie Percid Management Advisory Group (LEPMAG) to address stakeholder objectives, modeling concerns, and exploitation policies for Lake Erie percids. Previously, the QFC and LEPMAG completed a new statistical catch at age model (PR model; see section Statistical Catch-at-Age Analysis).

During 2018, LEPMAG developed a management strategy evaluation tool to evaluate current and alternative harvest strategies using the PR model. Management strategy evaluation was completed for all management units and new harvest control rules were selected (see Section Charge 2: Harvest Strategy and Recommended Allowable Harvest).

Charge 4: Improve existing population models

In 2018-2019, the YPTG examined all age-0 and age-1 recruitment indices used in the MMI model (see Section Statistical Catch at Age Analysis) to improve model stability and transparency. The YPTG determined that some of the indices that had been used in the model should be removed due to potential bias or changes in survey design. Surveys removed from the model include: 1) Management Unit 4, Long Point Bay summer Gill Net age-1 survey. This survey had a change in survey design in 2018 and is no longer a continuous time series; 2) Management Unit 2 and 3, Ohio summer trawl survey age-0 and age-1. These surveys were excluded due to the influence of hypoxia on survey results. Additional surveys had previously been excluded from the model if they were contained within a combined survey dataset or if it had already been decided they had

survey biases. A complete list of surveys included and excluded from the model is available in Appendix Table 4.

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Table 1.1. Lake Erie Yellow Perch harvest in pounds by management unit (Unit) and agency, 2009-2018

		Ontario*		Ohio		Michigan		Pennsylvania		New York		Total
	Year	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Harvest
Unit 1	2009	853,137	61	463,564	33	87,319	6	--	--	--	--	1,404,020
	2010	879,358	47	889,512	48	83,725	5	--	--	--	--	1,852,595
	2011	870,802	48	796,447	44	145,960	8	--	--	--	--	1,813,209
	2012	752,872	44	883,245	51	93,291	5	--	--	--	--	1,729,408
	2013	648,884	43	789,088	52	76,994	5	--	--	--	--	1,514,966
	2014	620,667	56	391,361	36	87,511	8	--	--	--	--	1,099,539
	2015	541,938	48	485,744	43	94,225	8	--	--	--	--	1,121,907
	2016	947,052	42	886,068	40	397,044	18	--	--	--	--	2,230,164
	2017	1,277,587	46	1,239,575	45	255,605	9	--	--	--	--	2,772,767
	2018	1,262,229	54	956,016	41	107,789	5	--	--	--	--	2,326,034
Unit 2	2009	2,495,611	58	1,801,978	42	--	--	--	--	--	--	4,297,589
	2010	1,888,876	56	1,457,823	44	--	--	--	--	--	--	3,346,699
	2011	1,665,258	54	1,399,503	46	--	--	--	--	--	--	3,064,761
	2012	1,877,615	50	1,851,846	50	--	--	--	--	--	--	3,729,461
	2013	1,803,684	51	1,721,668	49	--	--	--	--	--	--	3,525,352
	2014	1,679,175	52	1,543,226	48	--	--	--	--	--	--	3,222,401
	2015	1,489,433	57	1,131,993	43	--	--	--	--	--	--	2,621,426
	2016	1,283,379	62	792,869	38	--	--	--	--	--	--	2,076,248
	2017	1,498,437	70	643,554	30	--	--	--	--	--	--	2,141,991
	2018	1,271,365	69	559,122	31	--	--	--	--	--	--	1,830,487
Unit 3	2009	2,266,727	74	597,214	20	--	--	190,742	6	--	--	3,054,683
	2010	3,370,099	85	476,808	12	--	--	117,640	3	--	--	3,964,547
	2011	3,366,412	81	636,686	15	--	--	153,233	4	--	--	4,156,331
	2012	3,768,183	81	746,999	16	--	--	161,751	3	--	--	4,676,933
	2013	2,983,539	76	796,307	20	--	--	155,193	4	--	--	3,935,039
	2014	2,668,921	70	979,937	26	--	--	168,690	4	--	--	3,817,548
	2015	2,131,211	77	572,736	21	--	--	77,558	3	--	--	2,781,505
	2016	2,020,470	76	522,549	20	--	--	107,972	4	--	--	2,650,991
	2017	2,027,235	77	504,223	19	--	--	107,335	4	--	--	2,638,793
	2018	1,807,645	78	460,797	20	--	--	54,085	2	--	--	2,322,527
Unit 4	2009	272,579	72	--	--	--	--	37,991	10	70,030	18	380,600
	2010	467,612	89	--	--	--	--	19,989	4	37,730	7	525,331
	2011	468,001	80	--	--	--	--	37,040	6	80,848	14	585,889
	2012	502,778	77	--	--	--	--	41,362	6	106,499	16	650,639
	2013	496,666	72	--	--	--	--	74,277	11	119,869	17	690,812
	2014	485,899	74	--	--	--	--	16,671	3	149,668	23	652,238
	2015	297,716	76	--	--	--	--	10,055	3	85,535	22	393,306
	2016	231,063	87	--	--	--	--	6,791	3	28,078	11	265,932
	2017	179,730	76	--	--	--	--	16,078	7	39,598	17	235,407
	2018	272,733	90	--	--	--	--	1,452	0	29,159	10	303,344
Lakewide	2009	5,888,054	64	2,862,756	31	87,319	1	228,733	3	70,030	1	9,136,892
Totals	2010	6,605,945	68	2,824,143	29	83,725	1	137,629	1	37,730	<1	9,689,172
	2011	6,370,473	66	2,832,636	29	145,960	2	190,273	2	80,848	1	9,620,190
	2012	6,901,448	64	3,482,090	32	93,291	1	203,113	2	106,499	1	10,786,441
	2013	5,932,773	61	3,307,063	34	76,994	1	229,470	2	119,869	1	9,666,169
	2014	5,454,662	62	2,914,524	33	87,511	1	185,361	2	149,668	2	8,791,726
	2015	4,460,298	64	2,190,473	32	94,225	1	87,613	1	85,535	1	6,918,144
	2016	4,481,964	62	2,201,486	30	397,044	5	114,763	2	28,078	0	7,223,335
	2017	4,982,989	64	2,387,352	31	255,605	3	123,413	2	39,598	1	7,788,958
	2018	4,613,972	68	1,975,935	29	107,789	2	55,537	1	29,159	0	6,782,393

*processor weight (quota debit weight) to 2001; fisher/observer weight from 2002 to 2018 (negating ice allowance).

Table 1.2. Harvest, effort and harvest per unit effort summaries for Lake Erie Yellow Perch fisheries in Management Unit 1 (Western Basin) by agency and gear type, 2009-2018.

		Unit 1					
		Michigan	Ohio		Ontario Gill Nets		Ontario
	Year	Sport	Trap Nets	Sport	Small Mesh	Large Mesh*	Trap Nets
Harvest	2009	87,319	0	463,564	728,012	125,024	70
(pounds)	2010	83,725	195,674	693,838	815,170	64,188	0
	2011	145,960	156,138	640,309	792,336	78,363	103
	2012	93,291	0	883,245	718,585	34,172	115
	2013	76,994	0	789,088	608,241	40,617	26
	2014	87,511	0	391,361	596,956	23,633	78
	2015	94,225	0	485,744	533,167	8,712	59
	2016	397,044	103,345	782,723	938,558	8,445	49
	2017	255,605	447,263	792,312	1,271,282	5,466	839
	2018	107,789	439,720	516,296	1,248,042	14,031	156
Harvest	2009	40	0	210	330	57	0.03
(Metric)	2010	38	89	315	370	29	0.00
(tonnes)	2011	66	71	290	359	36	0.05
	2012	42	0	401	326	15	0.05
	2013	35	0	358	276	18	0.01
	2014	40	0	177	271	11	0.04
	2015	43	0	220	242	4	0.03
	2016	180	47	355	426	4	0.02
	2017	116	203	359	577	2	0.38
	2018	49	199	234	566	6	0.07
Effort	2009	130,556	0	578,303	3,058	1,680	
(a)	2010	132,852	2,607	798,240	3,152	845	
	2011	139,344	3,219	729,369	2,571	682	
	2012	128,013	0	896,083	2,244	438	
	2013	130,809	0	946,138	3,412	547	
	2014	76,996	0	630,989	3,398	362	
	2015	137,246	0	659,460	4,074	508	
	2016	251,426	2,446	824,418	6,091	431	
	2017	204,877	3,830	775,334	5,656	600	
	2018	137,930	3,500	500,695	5,143	667	
Harvest Rates	2009	2.7	--	3.1	108.0	33.8	
(b)	2010	2.3	34.0	3.4	117.3	34.4	
	2011	3.4	22.0	3.5	139.8	52.1	
	2012	2.4	--	3.6	145.3	35.4	
	2013	1.7	--	2.8	80.8	33.7	
	2014	2.2	--	3.0	79.7	29.6	
	2015	2.7	--	3.1	59.4	7.8	
	2016	4.8	19.2	4.1	69.9	8.9	
	2017	4.3	53.0	3.6	101.9	4.1	
	2018	2.3	57.0	3.2	110.1	9.5	

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts

(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

(c) the Ontario sport fishery harvested approximately 19,579 lbs of yellow perch in the 2014 creel survey

(*) large mesh catch rates are not targeted and are therefore of limited value.

Table 1.3. Harvest, effort and harvest per unit effort summaries for Lake Erie Yellow Perch fisheries in Management Unit 2 (western Central Basin) by agency and gear type, 2009-2018.

		Unit 2				
		Ohio		Ontario Gill Nets		Ontario
	Year	Trap Nets	Sport	Small Mesh	Large Mesh*	Trawls
Harvest	2009	1,338,616	463,362	1,994,208	482,402	17,315
(pounds)	2010	935,616	522,207	1,410,051	470,926	7,899
	2011	1,070,817	328,686	1,312,168	339,404	13,686
	2012	1,285,336	566,510	1,550,104	314,440	13,071
	2013	1,230,249	491,419	1,657,811	145,475	398
	2014	1,280,184	263,042	1,550,722	128,453	0
	2015	1,005,061	126,932	1,471,107	18,268	58
	2016	688,033	104,836	1,248,729	34,631	19
	2017	590,447	53,107	1,435,508	62,872	57
	2018	528,234	30,888	1,204,621	66,744	0
Harvest	2009	607	210	904	219	7.9
(Metric)	2010	424	237	639	214	3.6
(tonnes)	2011	486	149	595	154	6.2
	2012	583	257	703	143	5.9
	2013	558	223	752	66	0.2
	2014	581	119	703	58	0.0
	2015	456	58	667	8	0.0
	2016	312	48	566	16	0.0
	2017	268	24	651	29	0.0
	2018	240	14	546	30	0.0
Effort	2009	6,317	417,660	5,545	4,241	
(a)	2010	6,701	502,507	3,783	3,905	
	2011	5,707	395,407	4,214	3,789	
	2012	6,919	456,404	4,616	2,942	
	2013	5,851	428,187	6,821	1,951	
	2014	5,713	280,018	6,653	1,816	
	2015	6,309	217,637	9,459	1,207	
	2016	4,510	204,745	6,424	1,934	
	2017	2,567	119,163	6,094	1,946	
	2018	1,551	45,683	5,964	2,155	
Harvest Rates	2009	96.1	3.0	163.1	51.6	
(b)	2010	63.3	3.2	169.0	54.7	
	2011	85.1	2.6	141.2	40.6	
	2012	84.2	3.1	152.3	48.5	
	2013	95.4	2.6	110.2	33.8	
	2014	101.6	2.7	105.7	32.1	
	2015	72.2	1.5	70.5	6.9	
	2016	69.2	1.2	88.2	8.1	
	2017	104.3	1.0	106.8	14.7	
	2018	154.5	1.2	91.6	14.0	

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift
(c) the Ontario sport fishery harvested approximately 6,825 lbs of yellow perch in the 2014 creel survey
(*) large mesh catch rates are not targeted and therefore of limited value

Table 1.4. Harvest, effort and harvest per unit effort summaries for Lake Erie Yellow Perch fisheries in Management Unit 3 (eastern Central Basin) by agency and gear type, 2009-2018.

		Unit 3						
		Ohio		Pennsylvania		Ontario Gill Nets		Ontario
	Year	Trap Nets	Sport	Trap Nets	Sport	Small Mesh	Large Mesh*	Trawls
Harvest	2009	112,030	485,184	35,296	155,446	2,180,834	77,858	8,035
(pounds)	2010	153,097	323,711	36,026	104,224	3,065,336	302,410	2,353
	2011	327,871	308,815	1,542	151,691	2,911,506	451,628	3,278
	2012	469,401	277,598	15,405	146,346	3,653,296	114,640	247
	2013	300,346	495,961	790	154,403	2,818,241	164,712	586
	2014	265,963	713,974	506	168,184	2,597,079	71,136	706
	2015	266,030	306,706	6,854	70,704	2,084,595	43,072	3,544
	2016	349,844	172,705	51,148	56,824	2,003,842	16,459	169
	2017	449,979	54,244	45,741	61,594	1,964,728	61,127	1,380
	2018	439,233	21,564	51,093	2,992	1,743,484	63,902	259
Harvest	2009	51	220	16.0	70	989	35	3.6
(Metric)	2010	69	147	16.3	47	1,390	137	1.1
(tonnes)	2011	149	140	0.7	69	1,320	205	1.5
	2012	213	126	7.0	66	1,657	52	0.1
	2013	136	225	0.4	70	1,278	75	0.3
	2014	121	324	0.2	76	1,178	32	0.3
	2015	121	139	3.1	32	945	20	1.6
	2016	159	78	23.2	26	909	7	0.1
	2017	204	25	20.7	28	891	28	0.6
	2018	199	10	23.2	1	791	29	0.1
Effort	2009	482	289,602	121	139,438	4,050	728	
(a)	2010	972	182,485	128	85,294	5,747	1,125	
	2011	1,108	182,630	37	94,025	6,093	1,481	
	2012	2,074	154,474	87	98,234	7,847	991	
	2013	1,014	232,234	25	83,739	6,037	968	
	2014	581	336,607	186	90,024	5,678	422	
	2015	1,067	212,226	310	70,490	5,000	560	
	2016	2,000	181,622	604	57,545	5,964	798	
	2017	1,679	58,119	262	98,302	4,775	1,206	
	2018	2,233	16,805	324	7,836	5,204	1,031	
Harvest Rates	2009	105.4	3.5	132.3	4.8	244.2	48.5	
(b)	2010	71.4	4.0	127.6	4.0	241.9	121.9	
	2011	134.2	4.1	18.9	5.3	216.7	138.3	
	2012	102.6	4.5	80.3	4.7	211.1	52.5	
	2013	134.3	5.0	14.3	5.2	211.7	77.2	
	2014	207.6	4.0	1.2	4.7	207.4	76.4	
	2015	113.1	3.2	10.0	2.8	189.1	34.9	
	2016	79.3	1.9	38.4	2.0	152.4	9.4	
	2017	121.5	1.6	79.2	2.1	186.6	23.0	
	2018	89.2	2.1	71.5	0.3	151.9	28.1	

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift
(c) the Ontario sport fishery harvested approximately 132,585 lbs of yellow perch in the 2014 creel survey
(*) large mesh catch rates are not targeted and therefore of limited value

Table 1.5. Harvest, effort and harvest per unit effort summaries for Lake Erie Yellow Perch fisheries in Management Unit 4 (Eastern Basin) by agency and gear type, 2009-2018.

		Unit 4						
		New York		Pennsylvania		Ontario Gill Nets		Ontario
	Year	Trap Nets	Sport	Trap Nets	Sport	Small Mesh	Large Mesh*	Trawls
Harvest	2009	13,476	56,554	0	37,991	266,425	4,738	1,416
(pounds)	2010	11,772	25,958	0	26,263	465,775	1,517	320
	2011	15,045	65,803	0	37,040	464,331	2,761	909
	2012	17,709	88,790	0	41,362	499,359	833	2,586
	2013	15,814	104,055	0	74,277	492,233	2,778	1,665
	2014	10,355	139,313	0	16,671	482,925	1,160	1,814
	2015	21,503	64,032	0	10,055	295,833	1,083	800
	2016	11,465	16,613	0	6,791	230,333	65	665
	2017	12,366	27,232	0	16,078	177,475	32	2,223
	2018	10,657	18,502	0	1,452	271,795	583	355
Harvest	2009	6.1	25.6	0	17.2	120.8	2.15	0.6
(Metric)	2010	5.3	11.8	0	11.9	211.2	0.69	0.1
(tonnes)	2011	6.8	29.8	0	16.8	210.6	1.25	0.4
	2012	8.0	40.3	0	18.8	226.5	0.38	1.2
	2013	7.2	47.2	0	33.7	223.2	1.26	0.8
	2014	4.7	63.2	0	7.6	219.0	0.53	0.8
	2015	9.8	29.0	0	4.6	134.2	0.49	0.4
	2016	5.2	7.5	0	3.1	104.5	0.03	0.3
	2017	5.6	12.4	0	7.3	80.5	0.01	1.0
	2018	4.8	8.4	0	0.7	123.3	0.26	0.2
Effort	2009	215	58,829	0	58,475	718	50.9	
(a)	2010	287	35,526	0	26,544	1,227	21.7	
	2011	383	50,479	0	48,537	1,564	28.6	
	2012	428	58,621	0	49,577	1,770	12.9	
	2013	364	65,750	0	48,093	1,932	14.5	
	2014	213	76,817	0	13,959	2,016	8.3	
	2015	441	44,029	0	18,638	1,774	44.7	
	2016	248	27,436	0	11,934	1,303	11.2	
	2017	208	26,154	0	12,843	565	6.0	
	2018	135	19,035	0	3,940	887	58.7	
Harvest Rates	2009	28.4	1.77	--	3.2	168.3	42.2	
(b)	2010	18.6	1.31	--	2.2	172.1	31.7	
	2011	17.8	2.01	--	2.9	134.6	43.8	
	2012	18.8	2.17	--	2.5	127.9	29.3	
	2013	19.7	2.59	--	2.9	115.5	87.1	
	2014	22.0	2.78	--	2.3	108.6	63.4	
	2015	22.1	2.01	--	1.2	75.6	11.0	
	2016	21.0	0.95	--	1.3	80.1	2.6	
	2017	27.0	1.35	--	1.2	142.3	2.4	
	2018	35.8	1.53	--	0.4	139.0	4.5	

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift
(c) the Ontario sport fishery harvested approximately 21,361 lbs of yellow perch in the 2014 creel survey
(*) large mesh catch rates are not targeted and therefore of limited value

Table 1.6. Estimated 2018 Lake Erie Yellow Perch harvest by age and numbers of fish by gear and management unit (Unit).

		Unit 1		Unit 2		Unit 3		Unit 4		Lakewide	
Gear	Age	Number	%	Number	%	Number	%	Number	%	Number	%
Gill Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	221,302	5.9	239,857	7.0	473,032	9.1	437,054	54.6	1,371,245	10.4
	3	1,144,777	30.5	807,202	23.5	583,332	11.2	218,331	27.3	2,753,642	20.8
	4	1,931,417	51.4	2,087,075	60.7	2,855,601	54.8	118,011	14.7	6,992,104	52.9
	5	439,411	11.7	135,521	3.9	253,167	4.9	5,513	0.7	833,612	6.3
	6+	19,686	0.5	167,919	4.9	1,048,007	20.1	21,641	2.7	1,257,252	9.5
	Total	3,756,593	*54.7*	3,437,574	*74.6*	5,213,139	*81.2*	800,550	*92.8*	13,207,855	*70.4*
Trap Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	50,367	4.2	0	0.0	53,361	4.6	401	1.3	104,129	3.0
	3	408,430	34.4	401,798	35.9	359,986	30.8	3,811	12.7	1,174,025	33.5
	4	634,176	53.4	525,428	47.0	452,728	38.7	12,034	40.0	1,624,366	46.3
	5	48,603	4.1	79,844	7.1	43,909	3.8	2,407	8.0	174,763	5.0
	6+	45,918	3.9	110,752	9.9	259,838	22.2	11,432	38.0	427,940	12.2
	Total	1,187,494	*17.3*	1,117,822	*24.2*	1,169,822	*18.2*	30,084	*3.5*	3,505,222	*18.7*
Sport	1	34,015	1.8	0	0.0	0	0.0	0	0.0	34,015	1.7
	2	310,625	16.1	1,606	2.9	1,464	3.6	642	2.0	314,336	15.3
	3	546,043	28.3	12,232	22.1	7,434	18.2	10,752	33.4	576,461	28.1
	4	873,547	45.3	19,919	36.0	17,390	42.7	8,616	26.8	919,472	44.7
	5	148,466	7.7	8,301	15.0	2,689	6.6	2,344	7.3	161,800	7.9
	6+	13,942	0.7	13,222	23.9	11,765	28.9	9,830	30.5	48,759	2.4
	Total	1,926,638	*28.0*	55,280	*1.2*	40,742	*0.6*	32,184	*3.7*	2,054,844	*10.9*
All Gear	1	34,015	0.5	0	0.0	0	0.0	0	0.0	34,015	0.2
	2	582,294	8.5	241,463	5.2	527,857	8.2	438,097	50.8	1,789,710	9.5
	3	2,099,250	30.6	1,221,232	26.5	950,752	14.8	232,894	27.0	4,504,128	24.0
	4	3,439,140	50.1	2,632,422	57.1	3,325,719	51.8	138,661	16.1	9,535,942	50.8
	5	636,479	9.3	223,666	4.9	299,765	4.7	10,263	1.2	1,170,174	6.2
	6+	79,546	1.2	291,893	6.3	1,319,610	20.5	42,903	5.0	1,733,952	9.2
	Total	6,870,724	36.6	4,610,676	24.6	6,423,703	34.2	862,818	4.6	18,767,921	100.0

Note: Values in *italics* delineate harvest percentage by gear in each Unit, while the values in the 'All Gear' boxes are for lakewide harvest percentage by Unit.

Table 1.7. Yellow Perch stock size (millions of fish) in each Lake Erie management unit. Abundance in the years 2000 to 2019 are estimated by ADMB catch-age analysis.

	Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Unit 1	2	28.916	27.579	7.003	34.132	3.553	40.783	1.931	10.340	13.410	29.021	23.292	9.395	11.689	2.783	6.780	20.489	54.756	21.783	10.299	20.320
	3	6.650	18.391	17.841	4.451	21.509	2.240	25.807	1.224	6.539	8.654	18.493	14.599	5.886	7.206	1.675	4.174	12.491	32.557	13.249	6.457
	4	13.603	3.570	10.781	9.591	2.350	10.850	1.151	13.327	0.658	3.792	4.697	9.469	7.492	2.934	3.237	0.796	1.895	4.994	14.181	6.407
	5	2.665	5.866	1.879	4.699	4.145	0.865	4.158	0.444	5.964	0.341	1.702	1.889	3.834	3.072	0.981	1.147	0.257	0.458	1.390	4.685
	6+	0.964	1.339	3.506	2.116	2.590	2.011	0.945	1.582	0.847	3.270	1.521	1.131	1.053	1.781	1.388	0.733	0.501	0.144	0.122	0.367
	2 and Older	52.798	56.745	41.010	54.990	34.148	56.749	33.991	26.917	27.419	45.079	49.705	36.483	29.955	17.775	14.061	27.339	69.900	59.936	39.240	38.237
	3 and Older	23.882	29.166	34.007	20.858	30.594	15.966	32.060	16.577	14.008	16.058	26.413	27.088	18.266	14.992	7.281	6.850	15.144	38.153	28.941	17.917
Unit 2	2	51.190	47.834	11.437	97.637	6.497	172.902	7.230	24.241	25.904	58.888	45.338	8.200	20.852	12.891	31.927	10.483	40.739	22.073	12.407	19.691
	3	8.601	33.173	31.242	7.442	63.710	4.250	112.529	4.725	16.020	17.138	38.729	29.879	5.407	13.705	8.429	20.876	6.809	26.664	14.507	8.186
	4	16.115	4.708	19.124	17.423	4.196	36.496	2.352	63.270	2.887	9.901	10.071	23.249	17.937	3.173	7.715	4.681	10.903	3.779	15.290	8.574
	5	1.078	6.848	2.251	8.393	7.772	1.936	15.695	1.044	33.925	1.606	4.856	5.202	11.988	8.734	1.398	3.246	1.686	4.565	1.727	7.546
	6+	0.411	0.547	3.142	2.052	4.017	4.718	2.505	7.214	4.063	19.830	9.567	6.799	5.667	7.650	6.292	2.783	1.782	1.247	2.374	1.874
	2 and Older	77.395	93.108	67.196	132.948	86.192	220.302	140.311	100.495	82.798	107.363	108.560	73.329	61.852	46.153	55.761	42.069	61.919	58.328	46.305	45.871
	3 and Older	26.205	45.274	55.759	35.311	79.695	47.400	133.081	76.254	56.895	48.475	63.223	65.130	40.999	33.262	23.834	31.586	21.180	36.255	33.898	26.180
Unit 3	2	45.212	31.944	8.976	51.782	6.287	130.136	9.041	36.509	46.421	64.064	55.173	13.214	31.222	24.512	47.684	9.563	51.295	21.877	32.233	42.034
	3	9.180	30.136	21.290	5.977	34.493	4.188	86.754	6.025	24.362	31.004	42.759	36.819	8.816	20.814	16.339	31.732	6.367	34.116	14.574	21.468
	4	17.403	5.835	19.206	13.532	3.755	21.925	2.655	53.755	3.843	15.749	19.921	27.161	23.310	5.510	13.064	10.070	19.463	3.826	20.924	8.836
	5	2.203	10.032	3.390	11.126	7.481	2.167	12.475	1.388	31.029	2.321	9.334	11.335	15.309	12.647	3.029	6.790	5.135	9.319	1.946	10.237
	6+	1.290	1.822	6.303	5.013	7.893	7.975	5.121	7.912	4.827	20.350	12.227	11.024	11.270	12.619	12.209	6.643	5.761	4.217	5.827	3.109
	2 and Older	75.287	79.768	59.165	87.429	59.910	166.392	116.045	105.590	110.482	133.489	139.413	99.554	89.928	76.102	92.325	64.798	88.022	73.355	75.503	85.684
	3 and Older	30.075	47.824	50.189	35.647	53.622	36.256	107.004	69.080	64.060	69.425	84.240	86.340	58.706	51.590	44.641	55.235	36.727	51.478	43.271	43.651
Unit 4	2	7.849	3.033	1.641	4.156	0.898	6.312	0.767	6.736	4.558	5.220	6.788	0.758	7.741	1.688	3.381	0.643	4.065	5.842	12.511	2.277
	3	0.672	5.225	2.025	1.091	2.758	0.595	4.136	0.500	4.435	2.997	3.414	4.399	0.488	4.950	1.070	2.129	0.408	2.608	3.833	8.143
	4	1.180	0.437	3.444	1.310	0.700	1.753	0.361	2.458	0.310	2.735	1.803	1.974	2.462	0.266	2.600	0.547	1.123	0.226	1.591	2.261
	5	0.115	0.744	0.283	2.134	0.800	0.418	0.956	0.189	1.402	0.175	1.461	0.897	0.916	1.083	0.108	1.009	0.226	0.513	0.125	0.826
	6+	0.457	0.368	0.717	0.614	1.674	1.467	1.073	1.116	0.787	1.259	0.807	1.180	1.045	0.938	0.903	0.506	0.673	0.481	0.566	0.405
	2 and Older	10.272	9.808	8.110	9.306	6.830	10.545	7.293	10.999	11.492	12.387	14.272	9.207	12.652	8.926	8.063	4.835	6.494	9.670	18.625	13.911
	3 and Older	2.424	6.775	6.468	5.150	5.932	4.233	6.526	4.263	6.934	7.167	7.484	8.449	4.910	7.237	4.682	4.192	2.429	3.828	6.114	11.635

Table 2.1. Parameters of the stock-recruitment relationship, spawning stock biomass, limit reference point and target fishing rate for each management unit. F_{actual} may be reduced from F_{target} if P*>5%.

	Spawn/ Recruit Relationship Parameters			Spawning Stock Biomass (Unfished Population)		Spawning Stock Biomass (kgs)		Biomass at MSY (Limit Reference Point)			Fishing Rate			
Unit	log(alpha)	beta	sigma	SSB_0	sd($logSSB_0$)	2019	2020[a]	B_{msy}	%SSB_0	P*	F_{msy}	% F_{msy}	F_{target}	F_{actual}[b]
MU1	2.80	3.85E-07	0.96	5,645,560	0.22	2,795,920	3,171,970	1,585,743	28%	0.54%	2.38	28%	0.666	0.666
MU2	2.42	1.57E-07	0.96	12,378,700	0.19	4,700,430	4,076,090	3,395,611	27%	18.12%	2.06	35%	0.721	0.353
MU3	2.27	1.34E-07	0.96	12,895,400	0.22	6,775,030	7,236,280	3,542,554	27%	0.30%	2.03	32%	0.650	0.650
MU4	2.09	1.07E-06	1.01	1,791,990	0.21	2,087,220	1,791,180	506,007	28%	0.00%	1.46	34%	0.496	0.496

(a) Spawning stock biomass when population is fished at target fishing rate

(b) In MU2 fishing at F_{target} exceeds a 5% probability (P*) that the projected spawning stock biomass will be equal to or less than the limit reference point (B_{msy}), therefore the fishing rate was reduced until the probability was less than 5%.

Table 2.2. Estimated harvest of Lake Erie Yellow Perch for 2019 using the proposed fishing policy and selectivity-at-age from combined fishing gears.

		2019 Stock Size (millions of fish)			2019 Mean Biomass	Exploitation Rate				2019 Catch (millions of fish)			3-yr Mean Weight in	2019 Harvest Range Catch (millions of lbs)		
	Age	**Min.**	**Mean**	**Max.**	**mil. lbs**	**F [(a)]**	**s(age)**	**F(age)**	**(u)**	**Min.**	**Mean**	**Max.**	Harvest (kg)	**Min.**	**Mean**	**Max.**
Unit 1	2	13.538	20.320	27.103	4.510	0.666	0.111	0.074	0.059	0.797	1.196	1.595	0.122	0.214	0.322	0.429
	3	5.269	6.457	7.645	1.865	0.666	0.410	0.273	0.199	1.048	1.284	1.520	0.140	0.323	0.396	0.469
	4	5.253	6.407	7.562	2.157	0.666	0.729	0.485	0.322	1.692	2.064	2.436	0.157	0.586	0.714	0.843
	5	3.623	4.685	5.748	1.746	0.666	1.000	0.666	0.410	1.485	1.920	2.355	0.178	0.583	0.754	0.924
	6+	0.244	0.367	0.490	0.172	0.666	0.790	0.526	0.343	0.084	0.126	0.168	0.195	0.036	0.054	0.072
	Total	27.926	38.237	48.547	10.450				0.172	5.105	6.590	8.075	0.154	1.742	2.240	2.739
	(3+)	14.389	17.917	21.445	5.940				0.301	4.308	5.394	6.480	0.161	1.528	1.919	2.309
Unit 2	2	15.160	19.691	24.222	5.080	0.353	0.070	0.025	0.020	0.307	0.399	0.491	0.148	0.100	0.130	0.160
	3	6.941	8.186	9.432	2.936	0.353	0.357	0.126	0.098	0.681	0.803	0.926	0.156	0.234	0.276	0.318
	4	7.440	8.574	9.708	3.579	0.353	0.746	0.264	0.193	1.433	1.652	1.870	0.163	0.515	0.594	0.672
	5	6.448	7.546	8.644	3.433	0.353	1.000	0.353	0.248	1.600	1.873	2.145	0.173	0.611	0.714	0.818
	6+	1.504	1.874	2.244	1.171	0.353	0.999	0.353	0.248	0.373	0.464	0.556	0.195	0.160	0.200	0.239
	Total	37.493	45.871	54.250	16.200				0.113	4.395	5.192	5.988	0.167	1.620	1.914	2.208
	(3+)	22.333	26.180	30.027	11.120				0.183	4.087	4.792	5.497	0.169	1.520	1.784	2.048
Unit 3	2	28.561	42.034	55.507	8.496	0.650	0.022	0.014	0.012	0.334	0.492	0.649	0.133	0.098	0.144	0.190
	3	17.787	21.468	25.150	6.469	0.650	0.193	0.125	0.098	1.735	2.094	2.453	0.145	0.555	0.669	0.784
	4	7.411	8.836	10.262	3.462	0.650	0.531	0.345	0.243	1.803	2.150	2.497	0.160	0.636	0.759	0.881
	5	8.375	10.237	12.100	4.688	0.650	0.828	0.538	0.349	2.922	3.572	4.222	0.164	1.057	1.292	1.527
	6+	2.365	3.109	3.853	1.938	0.650	1.000	0.650	0.402	0.951	1.251	1.550	0.185	0.388	0.510	0.632
	Total	64.498	85.684	106.871	25.053				0.112	7.746	9.558	11.371	0.160	2.734	3.374	4.015
	(3+)	35.937	43.651	51.364	16.557				0.208	7.412	9.067	10.722	0.162	2.636	3.230	3.824
Unit 4	2	1.555	2.277	2.998	0.576	0.496	0.094	0.047	0.038	0.058	0.085	0.113	0.150	0.019	0.028	0.037
	3	6.657	8.143	9.630	3.735	0.496	0.413	0.205	0.154	1.024	1.253	1.481	0.166	0.375	0.459	0.542
	4	1.870	2.261	2.651	1.235	0.496	0.874	0.434	0.294	0.551	0.666	0.780	0.168	0.204	0.247	0.289
	5	0.671	0.826	0.981	0.532	0.496	1.000	0.496	0.328	0.220	0.271	0.322	0.179	0.087	0.107	0.127
	6+	0.325	0.405	0.484	0.322	0.496	0.679	0.337	0.239	0.078	0.097	0.115	0.202	0.035	0.043	0.051
	Total	11.079	13.911	16.744	6.399				0.170	1.931	2.371	2.812	0.169	0.720	0.883	1.047
	(3+)	9.523	11.635	13.746	5.824				0.196	1.872	2.286	2.699	0.170	0.700	0.855	1.010

(a) In MU2 fishing at F_{target} exceeds a 5% probability (P*) that the projected spawning stock biomass will be equal to or less than the limit reference point (B_{msy}), therefore the fishing rate was reduced until the probability was less than 5%.

Table 2.3. Lake Erie Yellow Perch fishing rates and the Recommended Allowable Harvest (RAH; in millions of pounds) for 2019 by Management Unit (Unit). RAH values may be subject to a limit on the annual change in TAC (±20%).

		Recommended Allowable Harvest (millions lbs.)			±20% of previous year TAC	
Unit	**Fishing Rate**	**MIN**	**MEAN**	**MAX**	MIN (-20%)	MAX (+20%)
1	0.666	1.742	2.240	2.739	2.425	3.637
2	0.353	1.620	1.914	2.208	2.590	3.884
3	0.650	2.734	3.374	4.015	3.021	4.531
4	0.496	0.720	0.883	1.047	0.363	0.545
Total		6.816	8.412	10.008	8.398	12.598

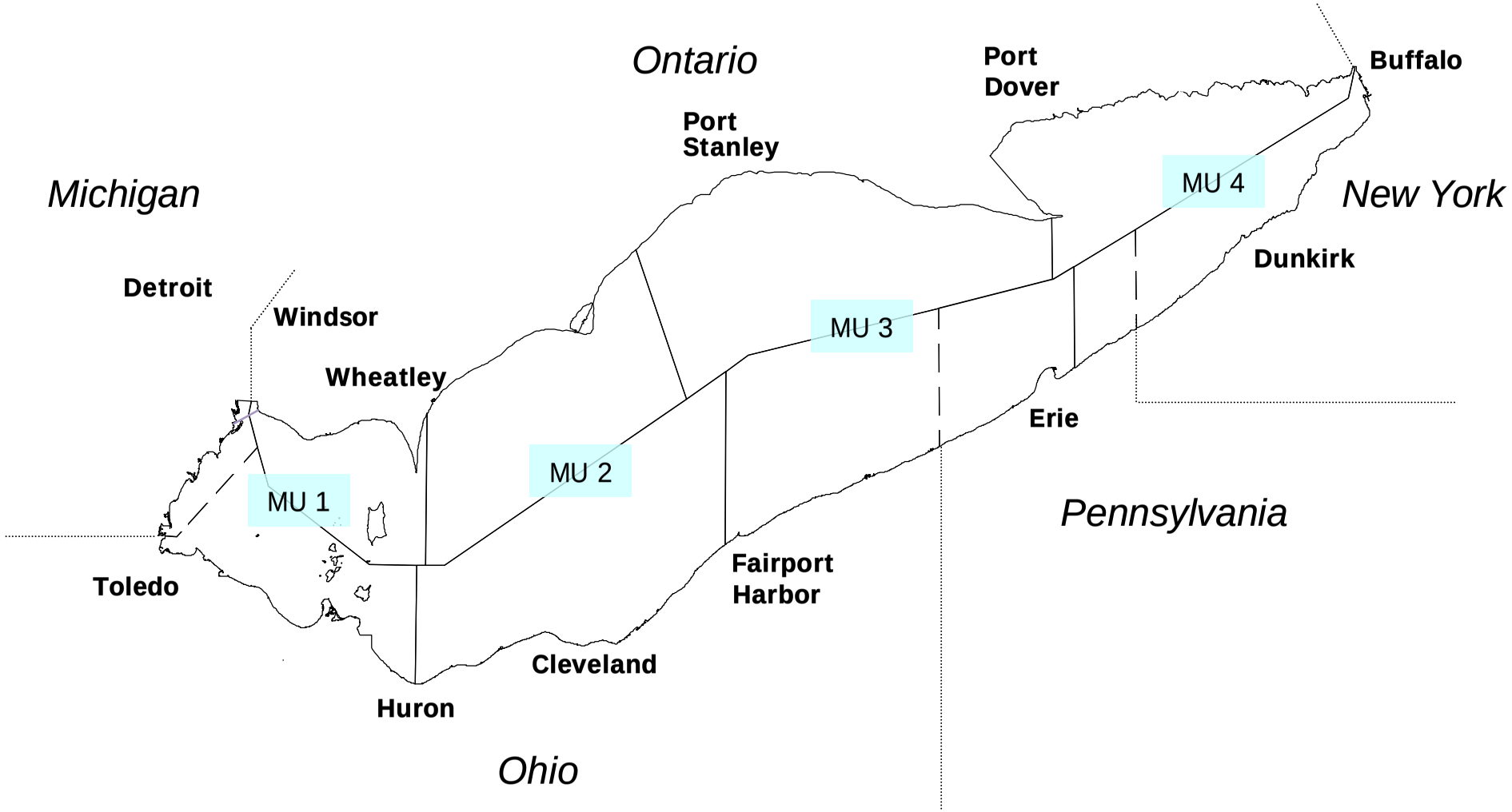


Figure 1.1. The Yellow Perch Management Units (MUs) of Lake Erie defined by the YPTG and LEC, for illustrative purposes.

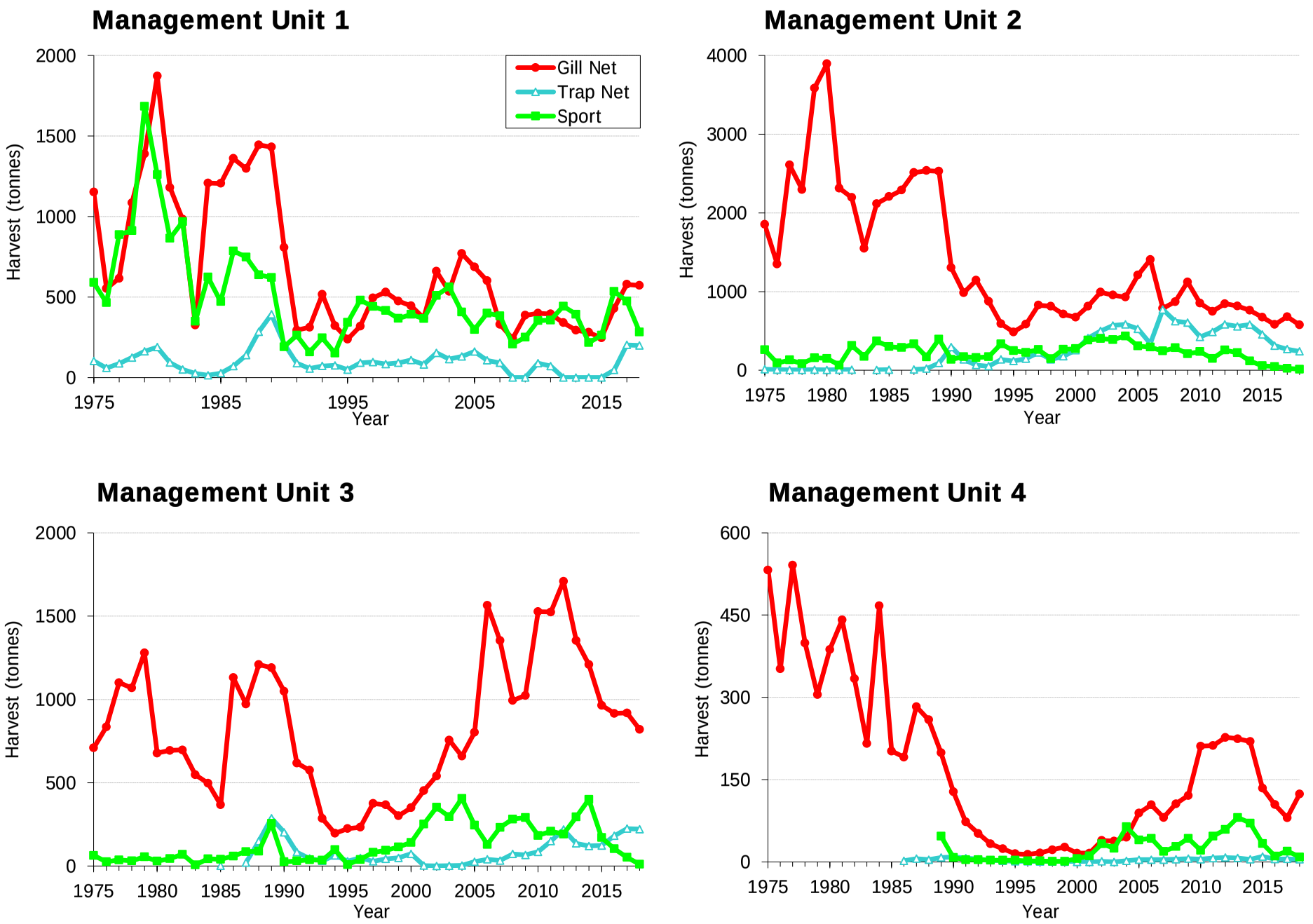


Figure 1.2. Historic Lake Erie Yellow Perch harvest (metric tonnes) by management unit and gear type.

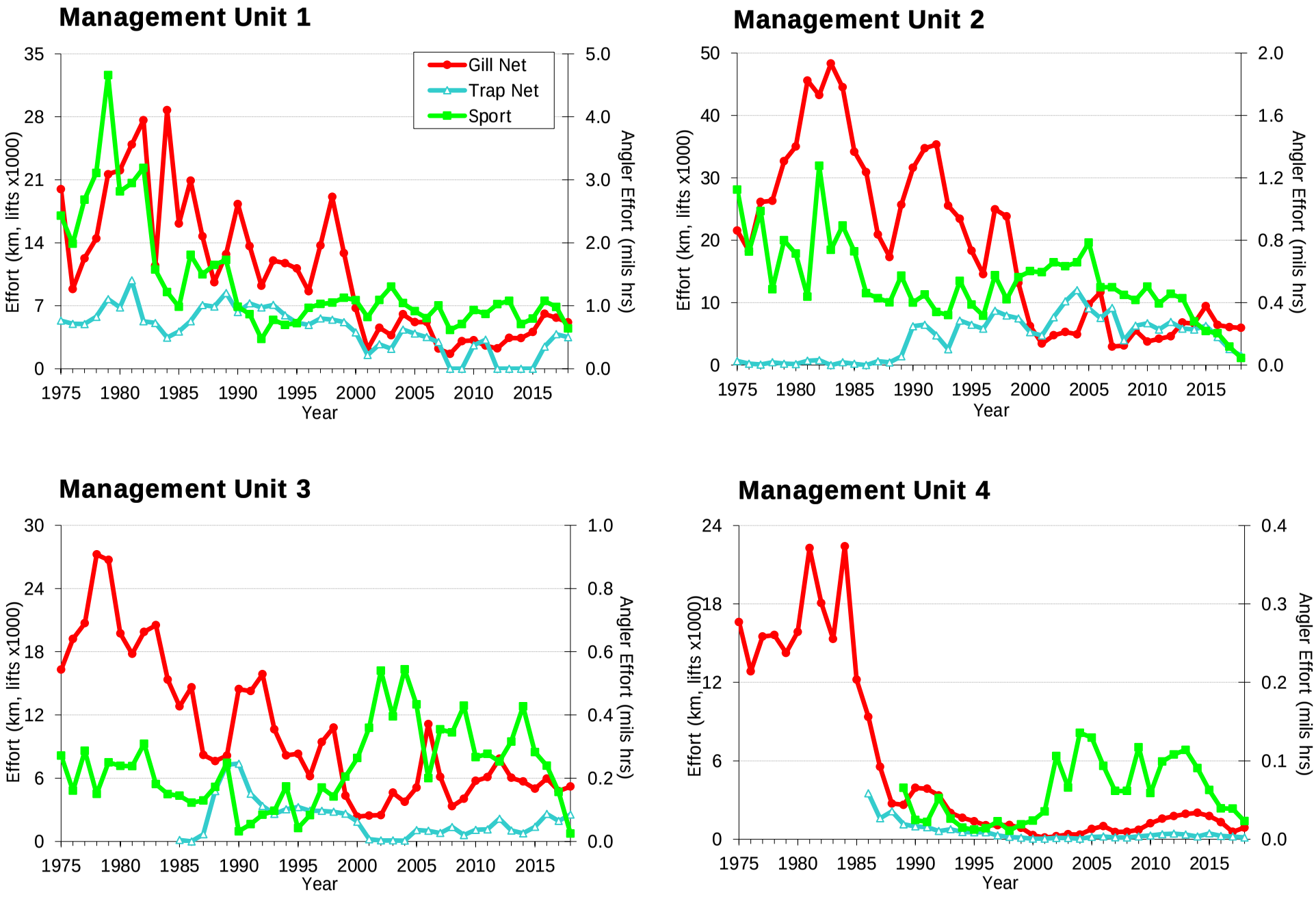


Figure 1.3. Historic Lake Erie Yellow Perch effort by management unit and gear type. Note: gill net effort presented is targeted effort with small mesh (< 3").

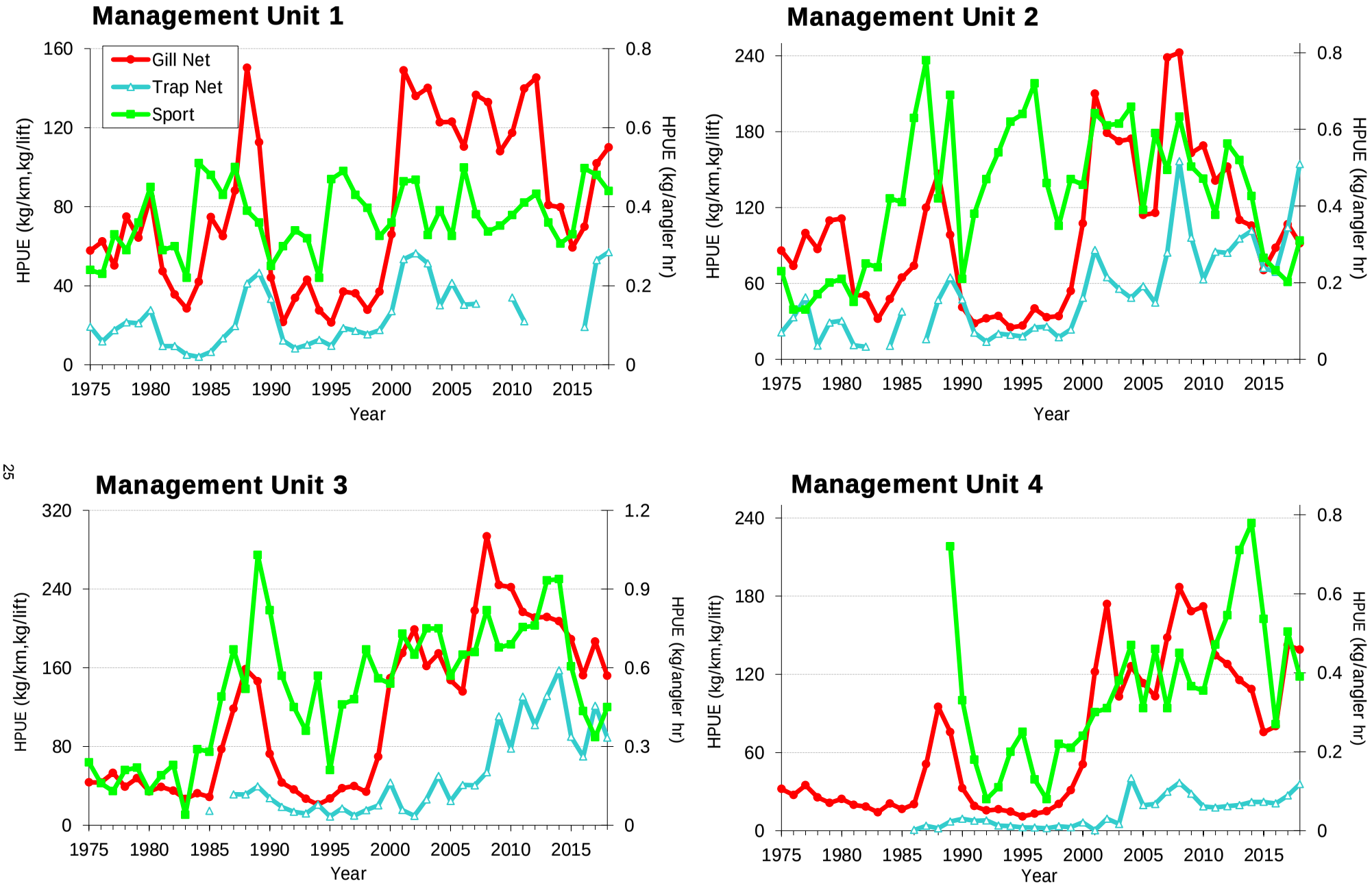


Figure 1.4. Historic Lake Erie Yellow Perch harvest per unit effort (HPUE) by management unit and gear type. Note: gill net CPUE for 2001 to 2018 is for small mesh (< 3") only.

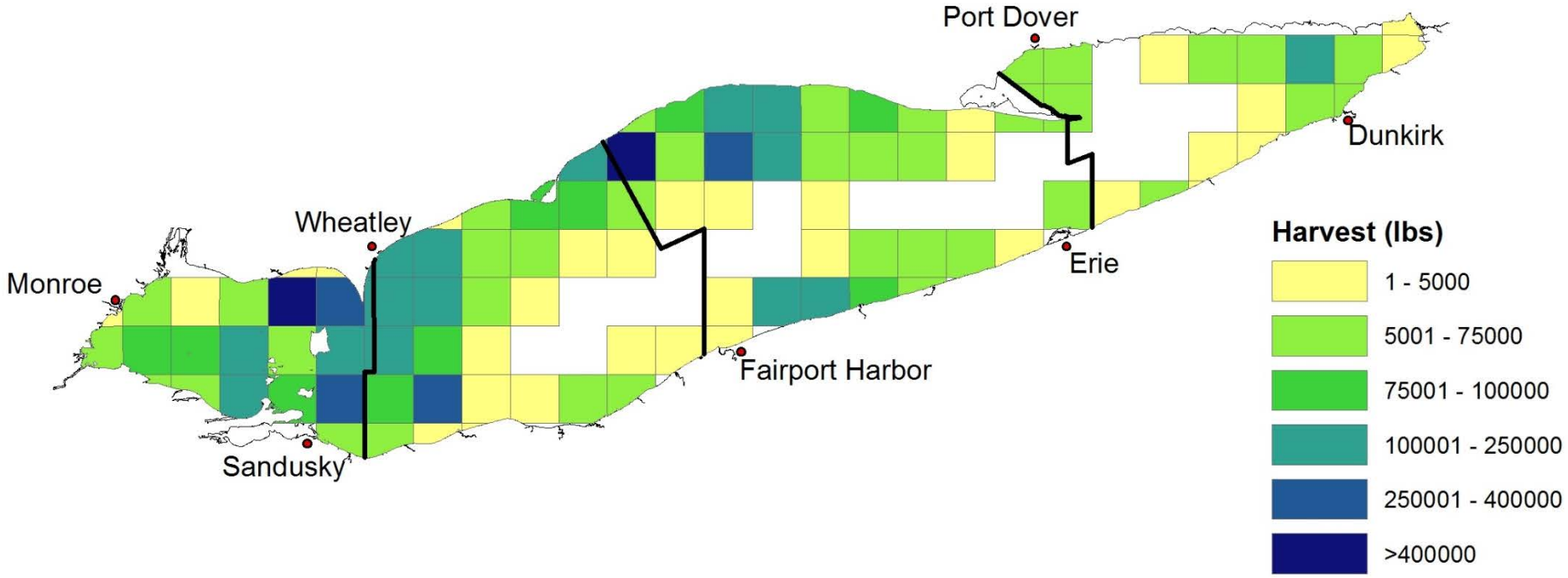


Figure 1.5. Spatial distribution of Yellow Perch total harvest (lbs.) in 2018 by 10-minute grid.

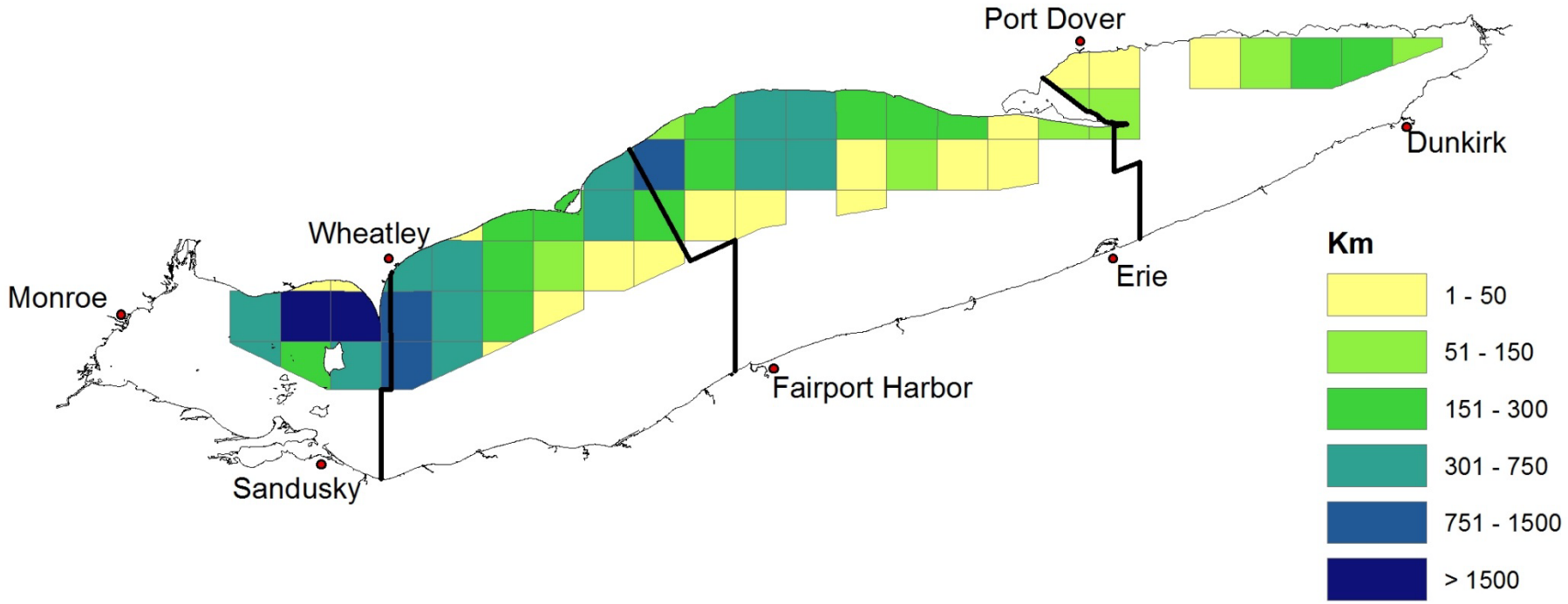


Figure 1.6. Spatial distribution of Yellow Perch small mesh gill net effort (km) in 2018 by 10-minute grid.

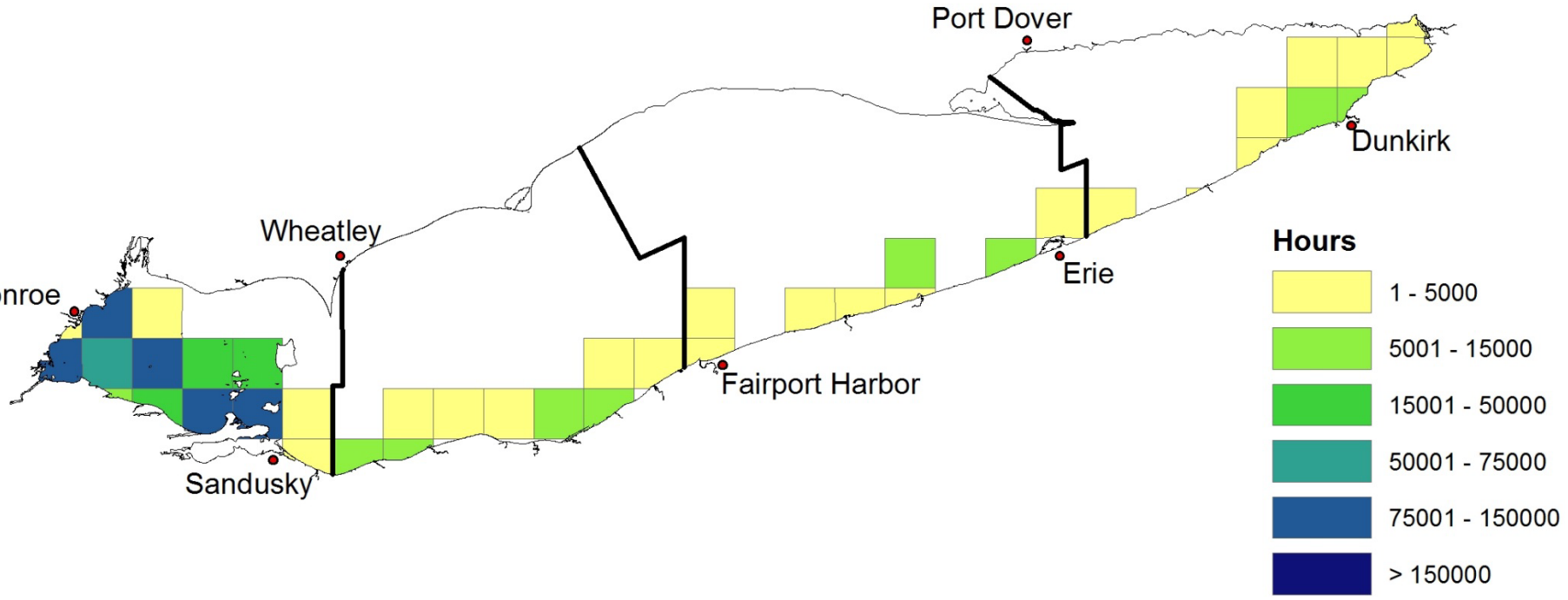


Figure 1.7. Spatial distribution of Yellow Perch sport effort (angler hours) in 2018 by 10-minute grid.

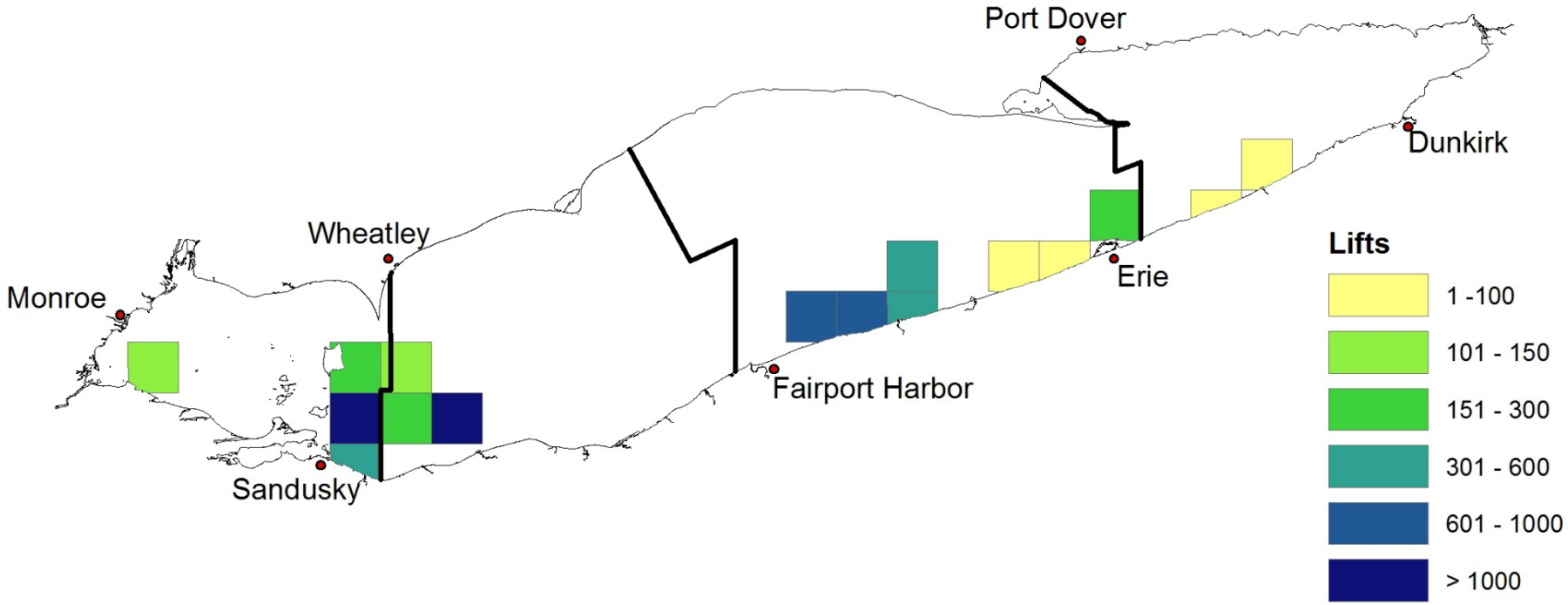


Figure 1.8. Spatial distribution of Yellow Perch trap net effort (lifts) in 2018 by 10-minute grid.

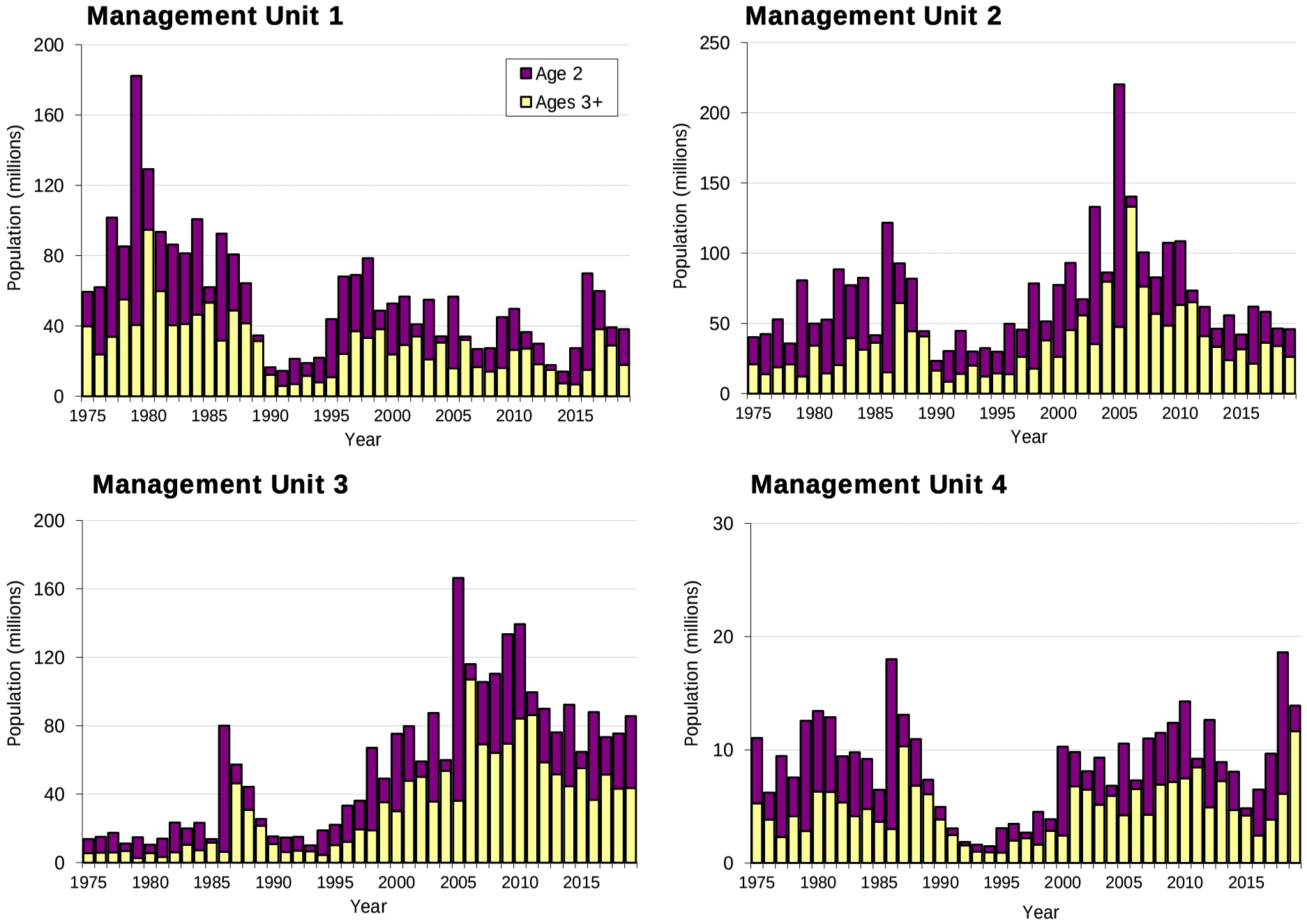


Figure 1.9. Lake Erie Yellow Perch population estimates by management unit for age 2 (dark bars) and ages 3+ (light bars), 1975 to 2019, from the PR ADMB model.

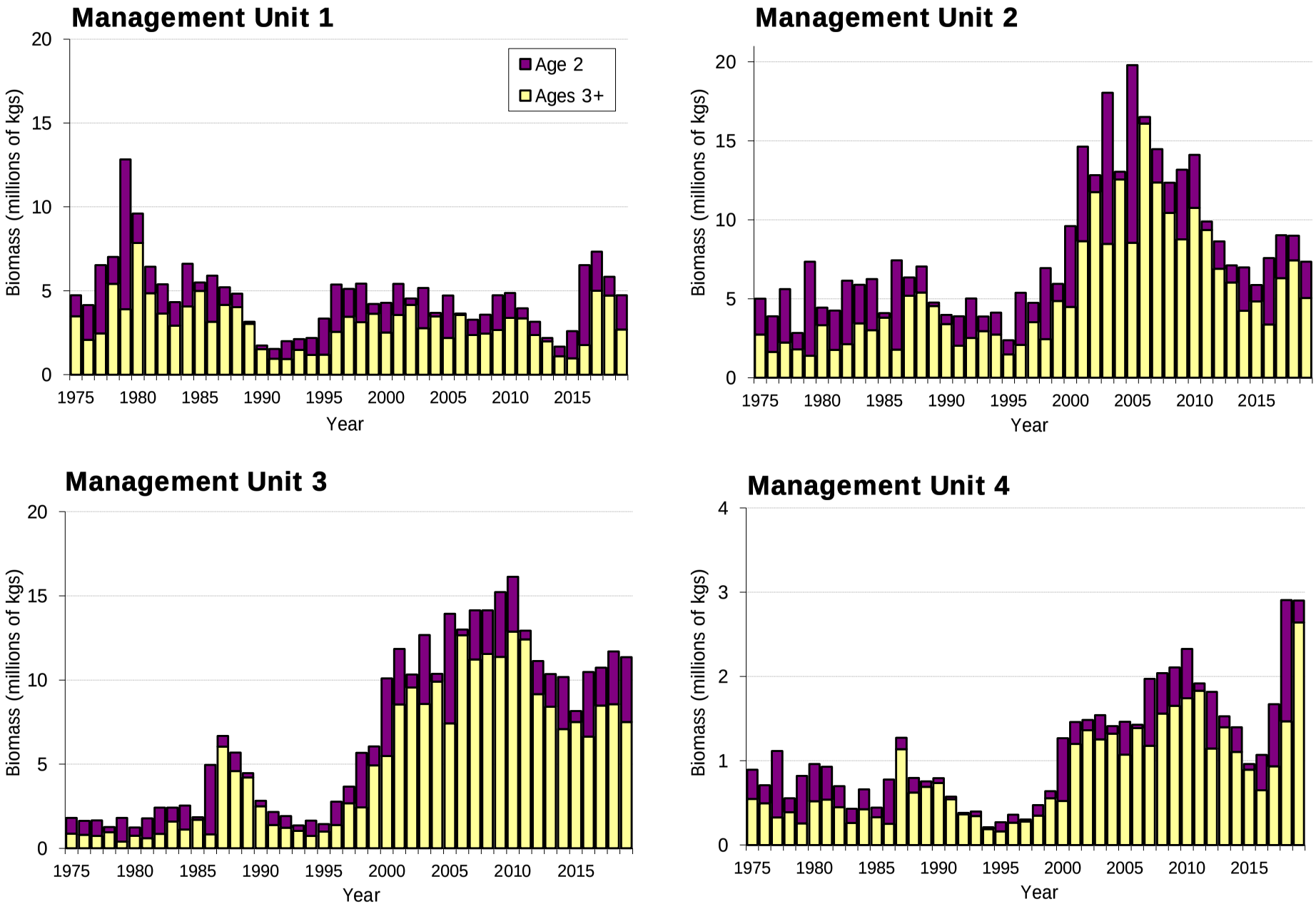


Figure 1.10. Lake Erie Yellow Perch biomass estimates by management unit for age 2 (dark bars) and ages 3+ (light bars), 1975 to 2019, from the PR ADMB model.

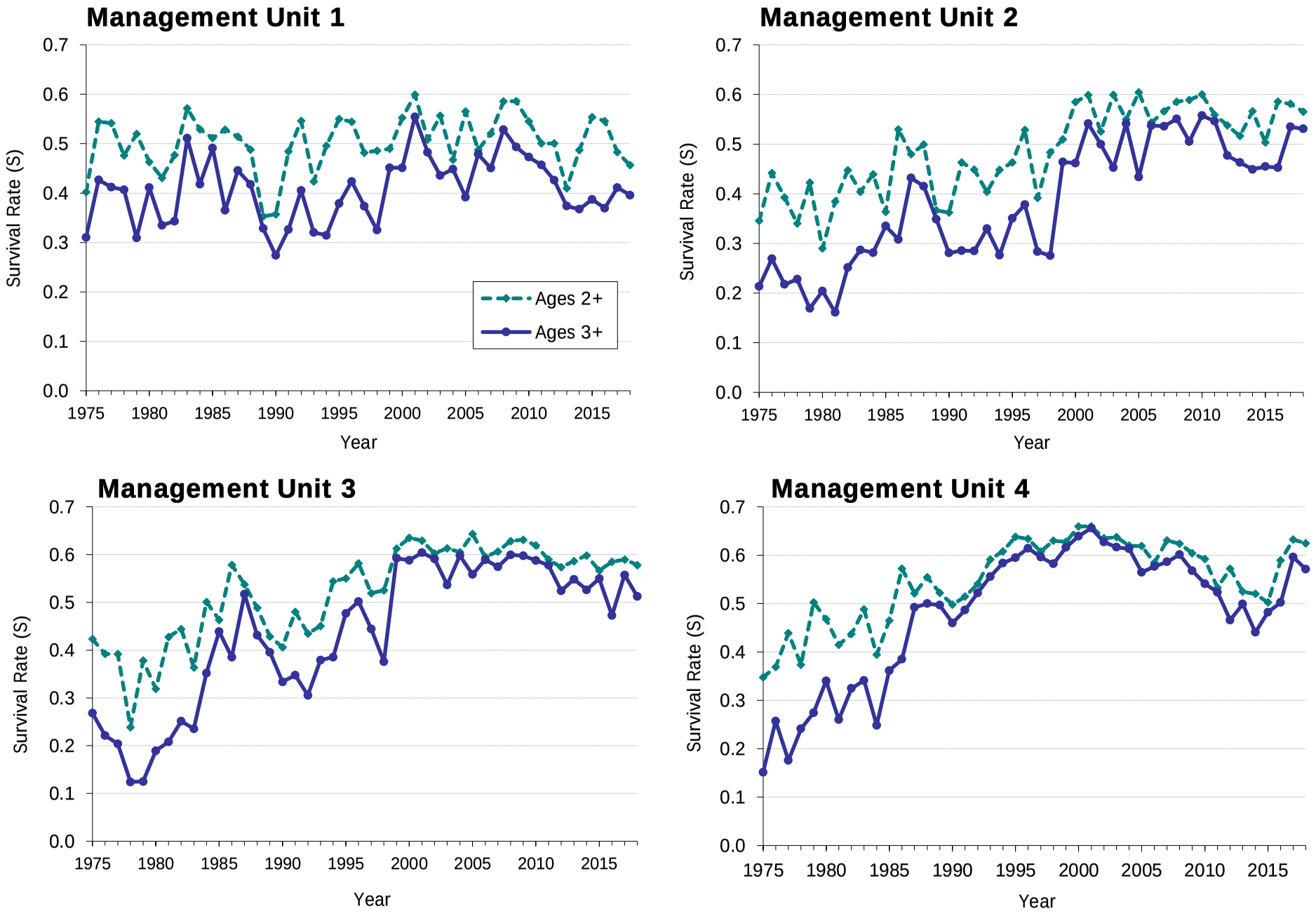


Figure 1.11. Lake Erie Yellow Perch survival rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line).

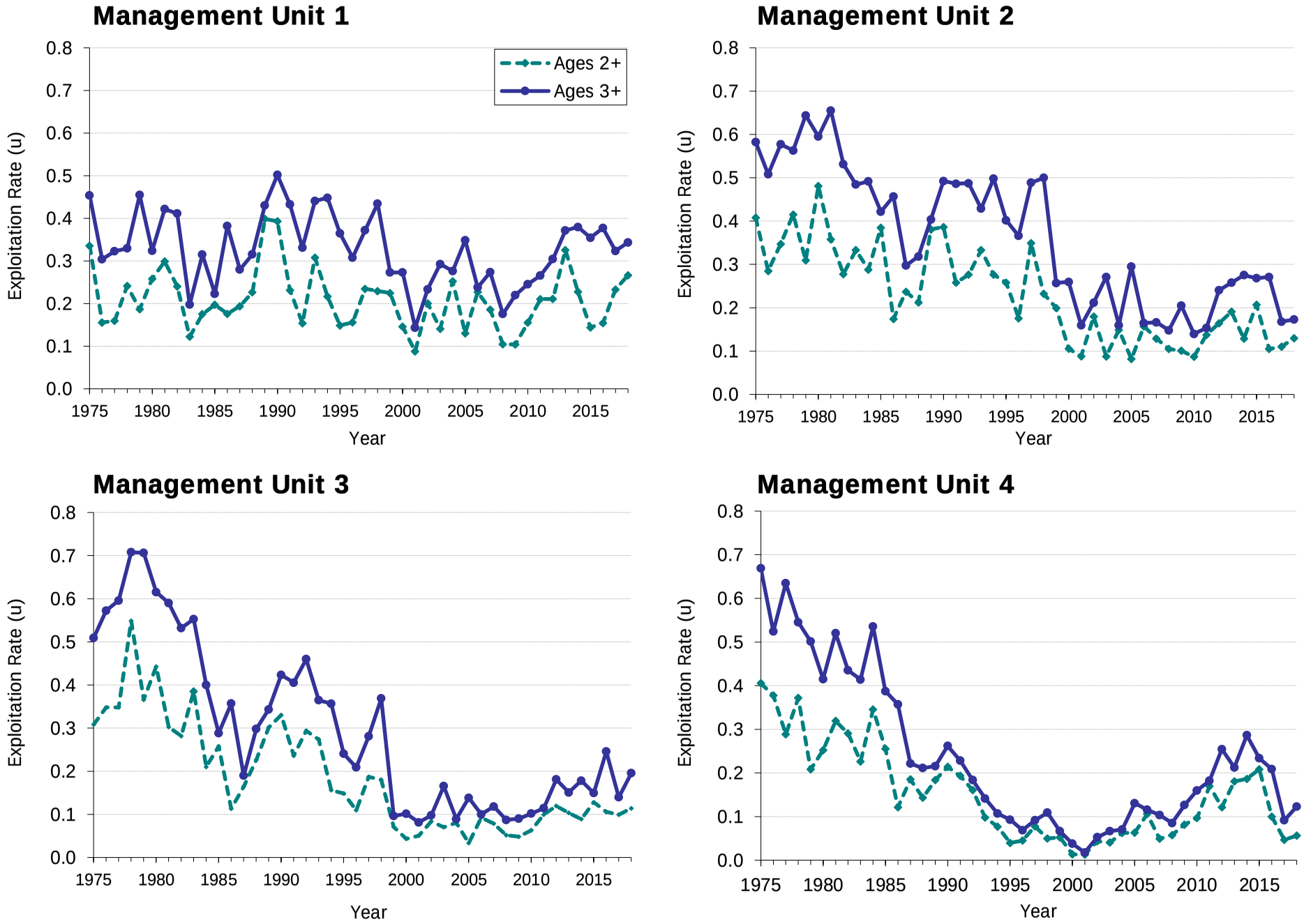
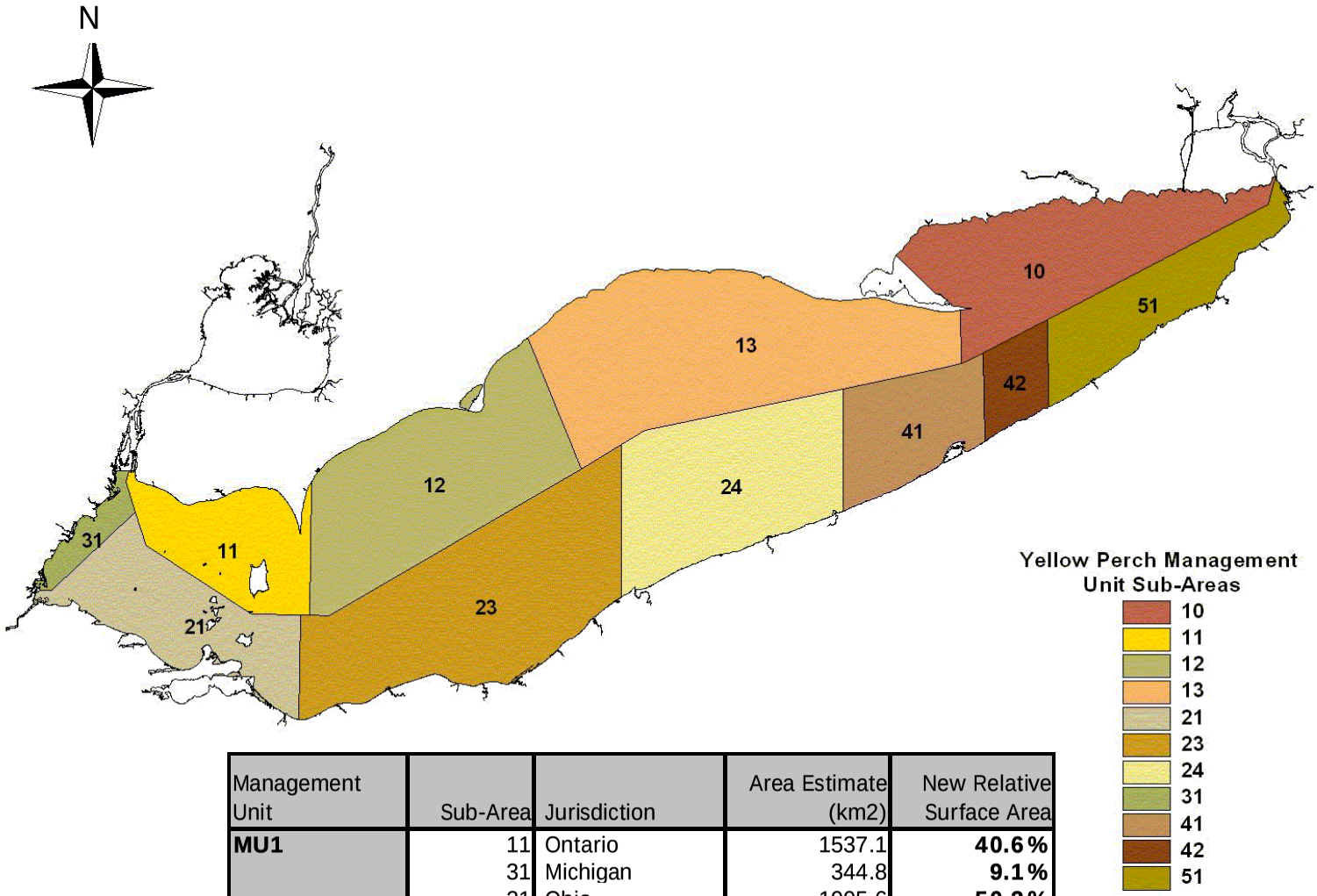


Figure 1.12. Lake Erie Yellow Perch exploitation rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line).



Management Unit	Sub-Area	Jurisdiction	Area Estimate (km2)	New Relative Surface Area
MU1	11	Ontario	1537.1	**40.6%**
	31	Michigan	344.8	**9.1%**
	21	Ohio	1905.6	**50.3%**
		MU1 Total	**3787.5**	
MU2	12	Ontario	3497.4	**45.6%**
	23	Ohio	4175.3	**54.4%**
		MU2 Total	**7672.7**	
MU3	13	Ontario	4749.9	**52.3%**
	24	Ohio	2943.7	**32.4%**
	41	Pennsylvania	1385.8	**15.3%**
		MU3 Total	**9079.4**	
MU4	10	Ontario	2818.7	**58.0%**
	42	Pennsylvania	535.6	**11.0%**
	51	New York	1507.2	**31.0%**
		MU4 Total	**4861.4**	

Figure 2.1. Calculations for subunit areas in the Yellow Perch Task Group Management Units.

Appendix Table 1. Expert Opinion (EO) Lambda (λ) values and relative number of terms associated with catch-at-age analysis data sources by management unit (Unit).

Unit	Data Source	λ	Relative Number of Terms
1	Commercial Gill Net Effort	0.8	1
	Sport Effort	0.7	1
	Commercial Trap Net Effort	0.5	1
	Commercial Gill Net Harvest	1.0	5
	Sport Harvest	0.9	5
	Commercial Trap Net Harvest	0.7	5
	Trawl Survey Catch Rates	1.0	3
	Partnership Gill Net Index Catch Rates	1.0	5
2	Commercial Gill Net Effort	0.8	1
	Sport Effort	0.8	1
	Commercial Trap Net Effort	0.6	1
	Commercial Gill Net Harvest	1.0	5
	Sport Harvest	0.9	5
	Commercial Trap Net Harvest	0.7	5
	Trawl Survey Catch Rates	0.9	4
	Partnership Gill Net Index Catch Rates	1.0	5
3	Commercial Gill Net Effort	0.8	1
	Sport Effort	0.8	1
	Commercial Trap Net Effort	0.6	1
	Commercial Gill Net Harvest	1.0	5
	Sport Harvest	0.8	5
	Commercial Trap Net Harvest	0.6	5
	Trawl Survey Catch Rates	1.0	4
	Partnership Gill Net Index Catch Rates	1.0	5
4	Commercial Gill Net Effort	0.8	1
	Sport Effort	0.7	1
	Commercial Trap Net Effort	0.6	1
	Commercial Gill Net Harvest	1.0	5
	Sport Harvest	0.7	5
	Commercial Trap Net Harvest	0.6	5
	NY Gill Net Survey Catch Rates	1.0	5
	Partnership Gill Net Index Catch Rates	0.9	5
	Long Point Bay Gill Net Index Catch Rates	1.0	5

Appendix Table 2. Surveys selected by multi-model inference (MMI) age-2 recruitment models run for each management unit.

MU	Number of Years in Model	Survey	Parameter Estimate	Number of Models
MU1	18	OOS11	0.148	1
		OOS10	0.347	2
		OPSF11	0.107	2
		(Intercept)	13.760	2
MU2	17	OHF20	0.264	1
		OPSF21	0.321	1
		(Intercept)	14.948	1
MU3	16	OHJ31	0.277	1
		OPSF31	0.335	1
		(Intercept)	14.847	1
MU4	14	LPC41	0.154	1
		NYF41	0.445	2
		(Intercept)	13.391	2

Appendix Table 3. Interagency trawl surveys indices. All trawl series are reported in arithmetic mean catch per hectare, all gill net series are in numbers of fish per lift. Trawl series in italics are not used to estimate age-2 recruitment.

Year	OHF10	OHF11	OOS10	OOS11	OHF20B	OHF21B	OHF30B	OHF31B	OHJ21B	OHJ31B	NYF40	NYF41	NYGN41	LPC40	LPC41	OPSF11	OPSF21	OPSF31	OPSF41
1988	.	.	212.6	13.3	.	.	.	.	.	.	.	.		105.8	0.4	.	.	.	.
1989	.	.	265.4	12.5	.	.	.	.	.	.	.	.		82.1	16.4	.	.	6.8	76.6
1990	310.1	0.0	259.2	35.2	52.2	23.0	21.2	12.4	.	.	.	.		26.7	5.6	41.3	68.9	29.7	0.6
1991	58.1	0.4	113.2	42.1	9.3	50.0	1.2	19.7	216.5	19.7	.	.	.	17.8	3.2	63.3	56.6	3.8	1.6
1992	90.9	0.7	94.1	16.5	36.3	15.0	31.3	3.3	18.5	0.8	10.7	2.4	.	70.3	4.6	47.5	8.0	5.7	6.3
1993	256.4	3.7	862.5	39.5	10.6	49.0	27.3	12.1	9.7	5.8	113.0	3.1	0.2	30.6	2.6	146.9	112.0	93.2	0.1
1994	287.1	73.1	469.7	62.9	71.9	12.0	16.1	3.4	23.3	10.2	49.0	8.6	0.6	34.7	6.2	317.8	22.5	39.7	7.4
1995	82.4	0.1	478.7	113.5	2.8	73.5	14.1	27.5	.	.	5.9	13.6	0.6	4.3	10.9	362.5	81.3	55.2	9.6
1996	579.3	82.3	2544.9	122.8	129.6	13.2	116.5	3.5	8.9	0.9	105.8	0.3	0.1	33.6	1.1	198.4	70.8	.	.
1997	33.7	104.9	55.2	93.8	11.6	147.3	2.6	40.0	493.9	64.0	0.2	5.7	0.0	4.4	7.1	139.3	350.5	177.9	.
1998	250.9	16.0	170.6	8.2	72.6	6.0	38.1	3.7	21.5	16.2	1.3	0.4	0.0	127.8	1.7	17.5	6.7	6.2	0.0
1999	155.3	47.1	330.0	75.0	68.3	41.8	25.7	41.7	402.8	97.3	35.9	33.3	13.1	16.1	110.0	440.6	107.6	67.9	119.9
2000	41.5	38.0	102.5	113.6	18.2	56.9	1.6	19.4	51.4	10.2	23.9	7.0	3.3	3.6	11.3	106.1	162.4	55.5	36.9
2001	246.3	10.3	398.4	11.3	119.2	5.3	13.6	0.4	279.8	4.3	100.4	11.7	2.2	69.4	2.0	12.9	9.6	1.9	9.5
2002	30.4	86.5	26.4	59.5	3.3	46.1	3.0	51.9	239.6	37.7	9.5	16.0	0.9	1.0	6.6	198.7	245.2	186.6	19.7
2003	1111.6	7.1	1620.8	12.3	136.9	2.9	53.2	1.0	9.5	2.5	484.8	2.0	2.0	222.8	2.3	2.7	2.6	7.2	3.2
2004	9.3	127.7	45.2	240.7	7.7	224.2	1.9	45.2	410.3	42.7	1.5	29.4	2.9	0.1	12.4	976.2	1187.6	332.5	7.6
2005	62.3	2.0	114.8	5.2	43.9	19.2	156.2	132.3	51.2	19.3	59.3	5.6	0.4	124.4	0.1	0.0	2.2	2.5	0.2
2006	121.9	12.5	222.8	12.4	11.3	4.3	18.9	12.5	29.7	113.6	290.6	40.9	32.6	30.1	12.1	15.7	28.5	94.8	129.7
2007	631.5	23.6	444.6	18.8	151.0	20.7	177.8	37.0	287.6	281.8	412.0	42.3	16.1	63.5	7.9	184.4	203.9	202.5	43.4
2008	74.7	15.3	387.2	142.1	32.1	55.0	52.8	26.4	303.5	97.2	1116.7	45.5	16.4	279.4	20.8	333.1	310.6	150.6	87.0
2009	69.4	57.0	136.6	88.4	1.6	20.2	0.5	139.4	125.9	48.2	11.9	64.1	42.4	0.4	10.7	265.2	121.4	190.0	30.6
2010	26.9	17.8	96.9	26.4	41.1	11.9	96.3	12.4	29.2	12.1	197.7	4.2	1.6	51.8	0.2	49.5	18.1	36.2	15.7
2011	12.0	10.0	178.0	25.9	10.3	6.3	15.1	55.5	70.8	41.7	89.5	141.8	105.9	176.7	2.6	158.7	101.8	218.6	95.4
2012	35.0	6.0	68.1	4.0	69.2	7.4	134.4	23.3	42.5	76.5	280.0	16.7	8.0	27.4	2.0	53.1	21.9	48.7	117.8
2013	337.0	3.7	315.6	17.8	8.9	34.9	8.9	109.5	84.2	116.2	4.4	24.4	16.0	0.5	0.8	64.1	71.4	152.1	30.4
2014	521.7	17.8	859.6	51.1	37.7	15.4	49.1	24.2	.	.	274.2	2.9	0.9	28.4	0.02	315.0	34.7	16.4	2.2
2015	224.0	53.0	494.3	117.2	19.6	41.3	18.6	30.2	.	.	68.6	57.3	2.0	58.5	1.6	424.3	66.5	212.7	170.9
2016	146.8	22.9	404.1	33.2	0.5	5.0	1.6	8.7	46.5	149.4	2178.2	53.0	10.4	360.6	91.7	105.6	50.4	35.1	298.2
2017	125.5	1.0	493.7	4.4	19.0	3.7	39.1	7.6	7.2	17.6	247.0	129.5	77.4	65.5	4.4	90.3	65.3	104.8	414.1
2018	429.6	17.4	959.3	21.6	28.4	7.9	50.8	6.6	14.9	50.4	662.4	11.4	1.7	328.8	2.9	78.5	28.3	130.2	23.3

Year	*OHS10*	*OHS11*	*OLPN40*	*OLPN41*	*ILP40*	*ILP41*	*OLPO40*	*OLPO41*	*OHJY20B*	*OHJY21B*	*OHJY30B*	*OHJY31B*	*LPS41*	OHS20B	OHS21B	OHS30B	OHS31B
1984	.	.	*283.9*	*9.7*	*761.7*	*44.5*	*7.3*	*0.0*					.	.	.	.	.
1985	.	.	*2.4*	*32.6*	*20.8*	*125.5*	*1.6*	*17.1*					.	.	.	.	.
1986	.	.	*102.0*	*0.2*	*1859.5*	*61.7*	*0.0*	*0.3*					*7.6*	.	.	.	.
1987	*16.3*	*74.9*	*3.4*	*284.1*	*3.8*	*39.7*	*0.0*	*2.1*					*5.5*	.	.	.	.
1988	*188.6*	*11.2*	*667.7*	*0.8*	*305.0*	*2.9*	*0.4*	*0.0*					*1.1*	.	.	.	.
1989	*106.1*	*11.8*	*296.9*	*53.2*	*457.7*	*84.6*	*0.4*	*1.9*					*6.3*	.	.	.	.
1990	*144.4*	*20.7*	*43.3*	*12.0*	*202.6*	*21.0*	*0.0*	*2.6*	*1.5*	*18.6*	*0.9*	*42.6*	*0.0*	*1.7*	*67.4*	*1.2*	*7.5*
1991	*146.9*	*27.6*	*15.5*	*1.0*	*144.0*	*24.5*	*0.7*	*0.6*			*0.0*	*0.0*	*1.7*	*5.4*	*43.5*	*5.2*	*77.7*
1992	*60.7*	*9.5*	*54.3*	*9.0*	*594.0*	*32.8*	*0.0*	*0.1*	*0.0*	*10.9*	*0.0*	*0.7*	*5.6*	*7.2*	*8.0*	*24.3*	*2.7*
1993	*1164.2*	*14.4*	*21.6*	*4.5*	*239.8*	*17.9*	*2.9*	*0.2*	*0.0*	*13.2*	*0.0*	*19.1*	*7.9*	*41.7*	*29.1*	*39.7*	*16.0*
1994	*508.5*	*57.7*	*159.8*	*15.3*	*84.0*	*29.8*	*10.6*	*1.7*	*518.8*	*5.3*	*265.8*	*13.0*	*2.7*	*73.3*	*5.0*	*77.2*	*16.7*
1995	*348.9*	*128.8*	*6.0*	*33.7*	*5.3*	*54.3*	*4.0*	*1.7*	*28.9*	*8.5*	*28.5*	*1.0*	*15.2*	*2.8*	*120.5*	*27.3*	*21.0*
1996	*3290.8*	*79.9*	*199.1*	*2.6*	*53.6*	*6.1*	*7.9*	*0.1*	*1464.4*	*2.9*	*558.3*	*1.2*	*0.4*	*1059.9*	*12.1*	*2006.8*	*3.6*
1997	*52.2*	*121.8*	*18.9*	*59.8*	*21.5*	*5.4*	*0.0*	*0.1*	*0.0*	*68.1*	*0.7*	*225.2*	*4.4*	*29.0*	*677.7*		
1998	*174.5*	*4.8*	*114.9*	*1.2*	*1005.9*	*14.9*	*8.1*	*0.0*					*8.4*	*225.4*	*3.4*	*275.5*	*3.7*
1999	*270.1*	*68.5*	*2.5*	*69.5*	*34.0*	*155.7*	*15.5*	*109.3*	*0.3*	*32.5*	*68.9*	*58.3*	*23.0*	*29.5*	*19.4*	*44.8*	*63.5*
2000	*186.4*	*85.3*	*10.2*	*2.1*	*1.2*	*4.8*	*3.0*	*13.4*	*0.0*	*129.3*	*1.1*	*28.7*	*0.7*	*0.6*	*86.6*	*0.0*	*84.8*
2001	*322.1*	*12.8*	*76.7*	*2.0*	*463.8*	*2.7*	*13.8*	*1.9*	*54.3*	*11.3*	*263.5*	*20.8*	*4.8*	*341.9*	*6.4*	*1283.7*	*10.2*
2002	*33.1*	*77.1*	*0.6*	*13.9*	*8.3*	*42.6*	*0.0*	*0.7*	*0.0*	*192.4*	.	.	*6.8*	*0.3*	*191.0*	*1.7*	*749.6*
2003	*1509.9*	*3.0*	*93.3*	*0.8*	*224.0*	*1.5*	*240.6*	*2.6*	*607.9*	*20.9*	*193.6*	*6.9*	*1.3*	*1180.4*	*3.8*	*1170.2*	*2.3*
2004	*40.9*	*210.7*	*0.5*	*4.3*	*0.1*	*21.4*	*0.1*	*12.2*	*0.0*	*60.5*	*0.2*	*55.9*	*6.5*	*32.8*	*316.2*	*3.6*	*61.9*
2005	*124.2*	*5.2*	*10.3*	*0.1*	*8.8*	*0.2*	*156.2*	*0.0*	*0.0*	*47.3*	*44.9*	*10.3*	*0.4*	*105.2*	*22.3*	*278.2*	*82.3*
2006	*180.2*	*6.4*	*2.8*	*1.4*	*0.3*	*4.8*	*38.0*	*14.6*	*13.4*	*78.0*	*250.8*	*14.3*	*19.5*	*4.9*	*2.2*	*60.7*	*10.8*
2007	*592.9*	*14.5*	*6.3*	*0.9*	*73.9*	*3.0*	*70.0*	*9.6*	*47.1*	*7.5*	*540.5*	*21.5*	*9.1*	*245.8*	*21.3*	*237.0*	*40.9*
2008	*267.0*	*23.5*	*4.9*	*6.6*	*0.3*	*4.1*	*356.0*	*25.1*	*2129.1*	*358.0*	*320.9*	*101.8*	*5.7*	*210.5*	*62.6*	*558.3*	*150.2*
2009	*186.0*	*85.3*	*1.5*	*4.2*	*0.0*	*0.0*	*0.3*	*13.1*	*0.0*	*24.2*	*0.0*	*109.9*	*0.7*	*14.2*	*62.7*	*0.1*	*104.3*
2010	*58.2*	*22.2*	*13.2*	*0.6*	*5.7*	*0.6*	*63.5*	*0.0*	*33.6*	*5.0*			*1.7*				
2011	*29.9*	*15.5*	*3.9*	*1.9*	*3.9*	*12.8*	*224.6*	*1.3*	*25.7*	*32.3*	*49.1*	*45.5*	*5.0*	*7.1*	*34.5*	*14.1*	*41.3*
2012	*74.5*	*2.3*	*11.3*	*1.1*	*1.6*	*1.7*	*33.2*	*2.2*	*133.4*	*19.0*	*164.6*	*32.5*	*13.7*	*65.9*	*9.2*	*154.3*	*23.5*
2013	*398.7*	*10.3*	*1.8*	*0.5*	*2.1*	*5.6*	*0.1*	*0.1*	*3.9*	*49.1*	*0.6*	*45.3*	*2.2*	*2.6*	*52.2*	*3.5*	*272.9*
2014	*668.9*	*17.4*	*80.1*	*0.2*	*4.7*	*0.0*	*24.6*	*0.0*					*0.9*	*33.6*	*2.8*	*45.8*	*15.4*
2015	*264.9*	*61.7*	*78.5*	*0.3*	*326.0*	*3.0*	*18.7*	*1.6*					*4.0*				
2016	*329.4*	*13.5*	*20.2*	*1.8*	*121.2*	*13.8*	*440.8*	*115.0*	*327.8*	*333.1*	*86.9*	*83.4*	*31.7*	*0.2*	*91.3*	*156.9*	*184.0*
2017	*279.5*	*2.7*	*84.4*	*3.0*	*52.1*	*0.9*	*64.7*	*5.1*	*328.4*	*4.7*	*454.3*	*13.2*	*37.6*	*191.8*	*3.3*	*1399.9*	*65.1*
2018	*514.1*	*10.5*	*739.9*	*1.4*	*818.3*	*19.9*	*204.1*	*0.8*	*60.9*	*4.6*	*308.6*	*31.5*		*11.9*	*17.6*	*77.7*	*15.6*

Appendix Table 4. Lakewide trawl index codes and series names used in Appendix Tables 2 and 3.
All series are reported in arithmetic mean catch per hectare, except LPS41, NYGN41, and OPSF11-41, gill net indices which are reported in mean catch per lift. Abbreviations in Appendix Table 3 ending with a 'B represent survey indices blocked by depth strata.
Reasons for inclusion or exclusion of surveys from the 2019 multi-model inference (MMI) process are included.

Abbreviation	Series	Used in 2019 MMI process	Reason for inclusion / exclusion (for next 5 years or until further research assessment)
OHS10	Ohio Management Unit 1 summer age 0	no	Data used in OOS10
OHS11	Ohio Management Unit 1 summer age 1	no	Data used in OOS11
OHF10	Ohio Management Unit 1 fall age 0	yes	consistent collection, broad spatial coverage, high selectivity, reduced mortality influence
OHF11	Ohio Management Unit 1 fall age 1	yes	consistent collection, broad spatial coverage, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OOS10	Ontario/Ohio Management Unit 1 summer age 0	yes	consistent collection, broadest spatial coverage, high selectivity, reduced mortality influence
OOS11	Ontario/Ohio Management Unit 1 summer age 1	yes	consistent collection, broadest spatial coverage, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHS20	Ohio Management Unit 2 summer age 0	no	hypoxic, 26 indices in 28 years, higher variability, low selectivity, influenced from mortality,
OHF20	Ohio Management Unit 2 fall age 0	yes	normoxic, 28 indices in 28 years, broad spatial coverage, lower variability, high selectivity, reduced mortality influence
OHS21	Ohio Management Unit 2 summer age 1	no	hypoxic, 26 indices in 28 years, higher variability, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHF21	Ohio Management Unit 2 fall age 1	yes	normoxic, 28 indices in 28 years, broad spatial coverage, lower variability, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHS30	Ohio Management Unit 3 summer age 0	no	hypoxic, 25 indices in 28 years, higher variability, low selectivity, influenced from mortality,
OHF30	Ohio Management Unit 3 fall age 0	yes	normoxic,28 indices in 28 years, broad spatial coverage, lower variability, high selectivity, reduced mortality influence
OHS31	Ohio Management Unit 3 summer age 1	no	hypoxic, 25 indices in 28 years, higher variability, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHF31	Ohio Management Unit 3 fall age 1	yes	normoxic, 28 indices in 28 years, broad spatial coverage, lower variability, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHJ21	Ohio Management Unit 2 June age 1	yes	normoxic,consistent collection, broad spatial coverage, lower variability, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHJ31	Ohio Management Unit 3 June age 1	yes	normoxic,consistent collection, broad spatial coverage, lower variability, high selectivity, reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHJY20	Ohio Management Unit 2 July age 0	no	some hypoxic, 23 indices in 28 years, higher variability, low selectivity, influenced from mortality,
OHJY30	Ohio Management Unit 3 July age 0	no	some hypoxic, 23 indices in 28 years, higher variability, low selectivity, influenced from mortality,
OHJY21	Ohio Management Unit 2 July age 1	no	some hypoxic, 23 indices in 28 years, higher variability, high selectivity,reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OHJY31	Ohio Management Unit 3 July age 1	no	some hypoxic, 23 indices in 28 years, higher variability, high selectivity,reduced mortality influence, temporally adjacent to spring Age-2 abundance (the target prediction)
OLPN40	Outer Long Point Bay Nearshore Management Unit 4 age 0	no	Data used in LPC40
OLPN41	Outer Long Point Bay Nearshore Management Unit 4 age 1	no	Data used in LPC41

Appendix Table 4 continued

Abbreviation	Series	Used in 2019 MMI process	Reason for inclusion / exclusion (for next 5 years or until further research assessment)
OLPO40	Outer Long Point Bay Offshore Management Unit 4 age 0	no	Data used in LPC40
OLPO41	Outer Long Point Bay Offshore Management Unit 4 age 1	no	Data used in LPC41
ILPF40	Inner Long Point Bay Management Unit 4 age 0	no	Data used in LPC40
ILPF41	Inner Long Point Bay Management Unit 4 age 1	no	Data used in LPC41
LPC40	Long Point Composite Management Unit 4 age 0	yes	The composite index is the most complete indicator of the state of age-0 yellow perch in Long Point Bay, as it encompasses all depth strata and has greater spatial coverage.
LPC41	Long Point Composite Unit 4 age 1	yes	The composite index is the most complete indicator of the state of age-1 yellow perch in Long Point Bay, as it encompasses all depth strata and has greater spatial coverage.
LPS41	Long Point Bay Management Unit 4 summer Gill Net age 1	no	Exclude from model due to change in survey design 2018
NYF40	New York Management Unit 4 fall trawl age 0	yes	This continuous 28-year index, has broad spatial coverage, consistent methodology, and is the only age-0 recruitment index for the south shore waters of MU4
NYF41	New York Management Unit 4 fall trawl age 1	yes	This continuous 28-year index, has broad spatial coverage, consistent methodology, and is one of two age-2 recruitment indicies for the south shore waters of MU4
NYGN41	New York Management Unit 4 gill net age 1	yes	This continuous 27-year index, has broad spatial coverage, consistent methodology, and is one of two age-2 recruitment indicies for the south shore waters of MU4
OPSF11	Ontario Partnership Gill Net Management Unit 1 fall age 1	yes	west basin age 1 index gill net catch rate (bottom nets) adjusted to equal effort among mesh sizes and for size selective bias of mesh configuration (Helser et al. 1998 normal gillnet selectivity retention curve); N usually 22 most years September
OPSF21	Ontario Partnership Gill Net Management Unit 2 fall age 1	yes	west central basin age 1 index gill net catch rate (bottom nets) adjusted to equal effort among mesh sizes and for size selective bias of mesh configuration (Helser et al. 1998 normal gillnet selectivity retention curve); N usually 36 Most years Oct, Nov
OPSF31	Ontario Partnership Gill Net Management Unit 3 fall age 1	yes	east central age 1 basin index gill net catch rate (bottom nets) adjusted to equal effort among mesh sizes and for size selective bias of mesh configuration (Helser et al. 1998 normal gillnet selectivity retention curve); N usually 36, Most years Oct, Nov
OPSF41	Ontario Partnership Gill Net Management Unit 4 fall age 1	yes	east basin index age 1 gill net catch rate (bottom nets < 30 m) adjusted to equal effort among mesh sizes and for size selective bias of mesh configuration (Helser et al. 1998 normal gillnet selectivity retention curve); N usually 20 @ depths < 30m, Most years Aug-Sep