Report of The

LAKE ERIE YELLOW PERCH TASK GROUP

March 1990

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Presented to:

Standing Technical Committee of the Lake Erie Committee
Great Lakes Fishery Commission

The Yellow Perch Task Group was charged with producing stock size estimates and recommending allowable harvests for 1990 in each of four management units (refer to Figure 1 for identification of these units). Agencies contributed summaries of harvest, fishing effort, age composition and relative abundance to the Task Group.

Fisheries Review

The reported harvest of yellow perch from Lake Erie in 1989 totaled 7,450 t (Table 1). The 1989 lakewide total harvest was 9% greater than in 1988. Ontario reported harvest levels similar to 1988 while Ohio, Michigan, and New York reported increases. (Table 2). Ontario accounted for 71% of the lakewide catch, Ohio 25%, Michigan 2%, Pennsylvania 1% and New York <1%. The reported harvest was within the 1989 recommended allowable harvest (RAH) in Unit 1 and Unit 4, however, the RAH was exceeded in Unit 2 by 16% and in Unit 3 by 32%. Agency management practices have for the most part been successful in restraining catches to near RAH levels (Table 3). Ontario and Pennsylvania reported that their commercial fisheries were further restricted by internal agency quotas. In 1989 Ontario had reduced its allocations in Units 3 and 4 and maintained calculated allocations at nearly the same levels as 1988 in Units 1 and 2.

Fishing effort (km of gill net) was standardized by the catch rate observed in Ontario's gill net fishery. In 1989 the lakewide standard fishing effort increased 49% from 1988. Significant increases of 29-65% occurred in all units (Table 1). Fishing effort remained less than the

target effort level in all units. Target effort was defined as a 20% reduction from the 1981 effort level. The 1989 reported fishing effort was more than 10% below the target level in Unit 1, near 40% below in Unit 2 and Unit 3, and 81% below in Unit 4.

Catch rates (kg/km of gill net) decreased in all units (Table 1) although catch rates were still high relative to levels observed in the early 1980s. The 1984 cohort was strongly represented in the harvest in all units (Table 4), but was particularly strong in Unit 3 and Unit 4 where it contributed 55% and 59% respectively. The 1985 and 1986 cohorts were the dominant cohorts in Unit 1 and Unit 2. Recruitment of the 1987 cohort was very poor in all units.

Stock Assessment

Age structured stock size was determined for each unit using a catch-at-age model (CAGEAN). A conservative estimate of natural mortality was used for stock reconstruction (M=0.20). Stock size estimates were totaled for age-2 and older and age-3 and older fish (Table 5). Age-2 fish have varied in their percent composition in the harvest but have been only lightly exploited relative to fully vulnerable age groups. Therefore stock size totals of age-3 and older better represent the portion of the stock that is vulnerable to fishing.

CAGEAN estimates of yellow perch stocks differed from the 1989 stock size projections presented in last years report (Table 6). There are two probable sources of error accounting for these differences. First, trawl indices of recruitment apparently overestimated the strength of the 1987 year class relative to their poor contribution in the 1989 fishery. Secondly, annual variation in the assessment of the

various fisheries, or the actual performance of the fishery, influence the annual catch per unit effort by age. The 1989 stocks of age-2 and older fish were similar to the predictions for Unit 1 (-12%) and Unit 2 (+20%). However predictions were in error by a considerable margin in Units 3 (+49%) Unit 4 (-47%).

There is no explanation for the poor recruitment of the 1986 cohort in Units 3 and Unit 4. Agency assessment surveys of adult yellow perch in 1988 and 1989 in Ontario, Ohio, and Pennsylvania indicated that the 1986 cohort comprised 12%-46% of the adult stock. No significant alteration in fishery strategies or exploitation tactics in Units 3 and 4 in 1989 have been reported that account for changes in catchability estimates, for example, which might explain the poor representation of this year class.

Projected Stock Size and Recommended Allowable Harvest in 1990

Stock size estimates from CAGEAN were projected to 1990 by simulating the effect of fishing and natural mortality on the 1989 estimated stock size. Recruitment of the 1988 cohort in 1990 was estimated from various agency trawling indices of age-0 and age-1 yellow perch (Table 7). Projections of stock size for 1990 indicate significant declines in the number of age-2 and older fish in all units (Table 5). The declines in stock size were due to high mortality rates and low estimates of recruitment for the 1988 cohort. Estimates for age-3 and older stock size decreased from 1989 levels in all units. These declines ranged from 40% in Unit-1 to 73% in Units 3 and Unit 4.

Recommended allowable harvests were subsequently calculated from the 1990 stock size. Mean age-specific catchability coefficients and

target fishing effort levels were used to determine exploitation rates as charged. Harvest in numbers at age was converted to harvest weight by using mean weight at age in the harvest. The 1990 allowable harvests derived from exploitation at target fishing effort are 2,820 t, 1,811 t, 1,016 t, and 174 t in Units 1-4 respectively. In Units 2-4 the harvests are about half the 1989 reported harvest despite the increase to target effort level. In Unit 1, the 1990 RAH is slightly larger than observed in 1989 because of the increased catchability of the strong 1986 cohort as age-4 fish as well as the increase to target effort level.

An initial exploitation strategy was established to attain a reduction in fishing mortality by 1990. Overall this objective has been reached. However, fishing at target effort levels in 1990 would result in exploitation rates for fully vulnerable age groups of 58%, 71%, 65%, and 91% in Units 1-4 respectively. More conservative exploitation strategies associated with sustainable yields demand significant declines in exploitation rates in all management units. Allowance harvests were calculated based on other more conservative exploitation strategies (i.e. maximum sustainable yield and optimum sustainable yield).

As a note of explanation, the MSY Effort option was derived from modeling historical population parameters (Yellow Perch Task Group, 1985 Report). Effort represents the peak of the dome of a yield - effort curve. Optimum F and Maximum F options were derived from yield per recruit functions. Stock weight at age was used to fix estimates of growth parameters. Maximum F relates to the peak value of yield on the yield per recruit vs. fishing mortality plot. Optimum F is equivalent

to F (0.1), taken as a more conservative fishing mortality from the ascending leg of the same plot.

A summary of 1990 recommended allowable harvests by agency was based on the relative percentage of water surface area within each unit (Table 10). Recommended allowable harvests based on target effort and allowable harvests based on other management options are presented for consideration.

Recommendations and Conclusions

Low yellow perch catch rates in 1989 indicated declines in stock size. Stocks are expected to decline in all management units in 1990. The strong 1984 cohort is still expected to contribute to the 1990 fishery as 6 year olds. It appears that particular cohort will be a substantial component of yield in MU 3 and 4 as a result of the expected weak contribution of the 1987 and 1988 year classes. Typically, 2 and 3 year old fish would be making a significant contribution. In Units 1 and 2, the 1986 year class will be the major contributor. Despite the appearance of the 1986 year class in index fishing assessment for the eastern portion of Lake Erie, it has yet to make a significant contribution in the fishery. Early indications are that the 1989 year class is not strong, therefore, stocks are expected to continue to decline in 1991.

Exploitation rates at target effort levels appear to be excessive, therefore, targeting at an MSY exploitation rate or less seems to be more reasonable. It can be reasoned that reduced exploitation will offer a greater yield per recruit over the long-term.

We are recommending that exploitation rates be reduced for yellow perch in 1990. The projections made through the task group modeling exercises for 1990 indicate a lower abundance of yellow perch. The reservations resulting from our population projections are strengthened when placing yellow perch in a fish community and ecosystem context. Maintaining yellow perch at some critical biomass is likely required to enable yellow perch to compete with the prolific and adaptable white perch. Yellow perch also are part of the fish community as prey for top level predators. Zebra mussels are expected to alter the energy dynamics of the Lake Erie ecosystem and hence the food chain. In order to withstand recent disruptions caused by continued introductions, yellow perch populations need to be maintained.

To add to our understanding of yellow perch populations and to enhance the confidence of our population estimates from CAGEAN, we strongly recommend that the issue of implementing standard lakewide juvenile/adult yellow perch assessment programs be addressed.

The YPTG recommends that the STC clarify the objectives for interagency management of yellow perch. We want to be able to evaluate exploitation strategies that are consistent with the long-term fish community goals.

Table 1. Catch and effort summaries for Lake Erie yellow perch by management unit, 1980-89.

Year	Unit 1	Unit 2	Unit 3	Unit 4	All Units
Catch (t)					
1980	3,323	4,052	708	387	8,470
1981	2,138	2,387	739	441	5,705
1982	2,001	2,518	768	334	5,621
1983	701	1,724	555	216	3,196
1984	1,846	2,495	542	467	5,320
1985	1,845	2,435	456	216	4,952
1986	2,217	2,578	1,191	163	6,149
1987	2,185	2,856	1,080	289	6,410
1988	2,367	2,729	1,448	263	6,807
1989	2,445	3,016	1,735	254	7,450
1989 RAH[a]	4,083	2,609	1,315	258	8,265
Standard Effort[b] (kms x 10^3)					
1980	39.4	34.6	22.8	16.8	113.6
1981	44.4	42.5	24.4	23.7	135.1
1982	55.6	49.5	21.0	19.3	145.3
1983	26.7	53.8	19.7	15.8	116.0
1984	41.7	51.6	16.5	24.7	134.4
1985	23.9	39.4	13.5	12.6	89.4
1986	34.2	34.4	15.0	11.6	95.1
1987	25.5	23.7	7.9	5.4	62.5
1988	16.6	18.8	8.3	2.8	46.5
1989	22.5	31.1	12.2	3.6	69.4
Target[c]	35.5	34.0	19.5	19.0	108.0
Catch Rate (kgs/km)					
1980	84.3	117.2	31.0	23.0	74.5
1981	48.2	56.1	30.2	18.6	42.2
1982	36.0	50.9	36.6	17.3	38.7
1983	26.3	32.1	28.1	13.6	27.5
1984	43.6	48.4	32.9	18.9	39.6
1985	71.3	63.9	30.5	16.0	54.1
1986	64.9	74.9	79.6	14.1	64.6
1987	85.7	120.5	136.7	53.5	102.6
1988	142.6	145.2	174.5	93.9	146.4
1989	108.8	96.8	142.7	71.0	107.2

[a]1989 recommended allowable harvest (RAH) based on 1989 CAGEAN projections and target fishing effort.

[b]Standard effort is calculated in terms of Ontario small mesh gill nets (see YPTG report, 1985).

[c]Target effort is 20% less than the effort observed in 1981.

Table 2. Summary of total catch[a] of yellow perch by management unit and agency, Lake Erie 1980-89.

Unit	Year	Ontario Catch	Ontario (%)	Ohio Catch	Ohio (%)	Michigan Catch	Michigan (%)	Pennsylvania Catch	Pennsylvania (%)	New York Catch	New York (%)	Total
1	1980	1,873	(56)	1,326	(41)	74	(02)	--	--	--	--	3,323
	1981	1,180	(55)	924	(43)	34	(02)	--	--	--	--	2,138
	1982	983	(49)	972	(49)	46	(02)	--	--	--	--	2,001
	1983	326	(47)	358	(51)	17	(02)	--	--	--	--	701
	1984	1,208	(65)	608	(33)	30	(02)	--	--	--	--	1,846
	1985	1,347	(73)	476	(26)	22	(01)	--	--	--	--	1,845
	1986	1,360	(61)	775	(35)	82	(04)	--	--	--	--	2,217
	1987	1,298	(59)	785	(36)	102	(05)	--	--	--	--	2,185
	1988	1,445	(61)	846	(36)	76	(03)	--	--	--	--	2,367
	1989	1,432	(59)	862	(35)	151	(06)	--	--	--	--	2,445
2	1980	2,877	(71)	1,175	(29)	--	--	--	--	--	--	4,052
	1981	1,603	(67)	784	(33)	--	--	--	--	--	--	2,387
	1982	2,162	(86)	356	(14)	--	--	--	--	--	--	2,518
	1983	1,466	(85)	258	(15)	--	--	--	--	--	--	1,724
	1984	2,117	(85)	378	(15)	--	--	--	--	--	--	2,495
	1985	2,127	(87)	308	(13)	--	--	--	--	--	--	2,435
	1986	2,289	(89)	289	(11)	--	--	--	--	--	--	2,578
	1987	2,512	(88)	344	(12)	--	--	--	--	--	--	2,856
	1988	2,538	(93)	191	(07)	--	--	--	--	--	--	2,729
	1989	2,530	(84)	486	(16)	--	--	--	--	--	--	3,016
3	1980	478	(68)	144	(20)	--	--	86	(12)	--	--	708
	1981	505	(68)	131	(18)	--	--	103	(14)	--	--	739
	1982	615	(80)	89	(12)	--	--	64	(08)	--	--	768
	1983	519	(94)	21	(04)	--	--	15	(03)	--	--	555
	1984	466	(86)	44	(08)	--	--	32	(06)	--	--	542
	1985	370	(81)	43	(09)	--	--	43	(09)	--	--	456
	1986	1,101	(92)	60	(05)	--	--	30	(03)	--	--	1,191
	1987	908	(84)	108	(10)	--	--	64	(06)	--	--	1,080
	1988	1,128	(78)	239	(17)	--	--	81	(06)	--	--	1,448
	1989	1,095	(63)	544	(31)	--	--	96	(06)	--	--	1,735
4	1980	303	(78)	--	--	--	--	42	(11)	42	(11)	387
	1981	355	(80)	--	--	--	--	33	(07)	53	(12)	441
	1982	253	(76)	--	--	--	--	29	(09)	52	(16)	334
	1983	175	(81)	--	--	--	--	13	(06)	28	(13)	216
	1984	365	(78)	--	--	--	--	35	(07)	67	(14)	467
	1985	190	(75)	--	--	--	--	14	(05)	51	(20)	255
	1986	143	(88)	--	--	--	--	16	(11)	2	(01)	161
	1987	260	(90)	--	--	--	--	23	(08)	6	(02)	289
	1988	258	(98)	--	--	--	--	1	(<1)	4	(02)	263
	1989	199	(78)	--	--	--	--	0	(00)	55	(22)	254

[a]Catch is in tonnes.
Values in parentheses represent each agency's percentage of management unit catch.

Table 3. Lake Erie Management Unit compliance with 1989 recommended allowable harvests (RAH) of yellow perch.

UNIT	AGENCY	RAH (t)	HARVEST (t)	DIFFERENCE (t)	DIFFERENCE (%)
1	Ontario	1,727	1,432	-295	-17.1
	Ohio	2,025	862	-1,163	-57.4
	Michigan	331	151	-180	-54.4
	Total	**4,083**	**2,445**	**-1,638**	**-40.1**
2	Ontario	1,109	2,530	1,421	128.1
	Ohio	1,501	486	-1,015	-67.6
	Total	**2,610**	**3,016**	**406**	**15.6**
3	Ontario	738	1,095	357	48.4
	Ohio	419	544	125	29.8
	Pennsylvania	156	96	-60	-38.5
	Total	**1,313**	**1,735**	**422**	**32.1**
4	Ontario	142	199	57	40.1
	Pennsylvania	44	0	-44	-100.0
	New York	71	55	-16	-22.5
	Total	**257**	**254**	**-3**	**-1.2**

Table 4. Harvest of yellow perch (millions of fish) from Lake Erie by management unit, 1989.

YEAR CLASS	UNIT 1		UNIT 2		UNIT 3		UNIT 4	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
1987	0.4	0.2	1.8	0.8	0.2	0.2	0.1	0.7
1986	59.3	30.5	103.0	47.5	19.5	18.1	3.3	21.9
1985	74.1	38.1	52.1	24.0	22.1	20.5	3.2	21.2
1984	52.9	27.2	58.8	27.1	63.7	59.0	8.3	55.0
1983	3.9	2.0	0.6	0.3	1.3	1.2	0.2	1.3
1982	3.3	1.7	0.5	0.2	1.0	0.9	0.0	0.0
1981	0.5	0.3	0.0	0.0	0.1	0.1	0.0	0.0
TOTAL	194.4		216.8		107.9		15.1	

Table 5. Yellow perch stock size (millions of fish present at the beginning of the year) estimated from CAGEAN model (1980-89) and 1990 projections based on stock survival estimates and recruitment estimates from agency trawl indices.

UNIT	AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	2	18.33	17.47	25.73	22.25	41.66	7.37	67.51	36.46	41.02	1.32	11.98
	3	49.18	13.63	12.69	16.90	16.46	32.19	5.79	52.10	28.54	32.43	1.04
	4	6.37	24.37	5.98	3.30	8.17	8.97	19.65	3.12	31.08	18.29	20.88
	5	2.89	1.66	4.84	0.36	0.81	2.54	3.65	5.96	1.20	14.21	8.46
	6	0.44	0.87	0.50	0.32	0.17	0.31	1.16	1.46	2.86	1.86	7.43
Total	(+2)	77.21	58.00	49.74	43.13	67.27	51.38	97.76	99.10	104.70	68.11	49.79
Total	(+3)	58.88	40.53	24.01	20.88	25.61	44.01	30.25	62.64	63.68	66.79	37.81
2	2	11.92	19.66	42.76	23.48	29.95	4.00	82.27	19.68	34.59	1.66	6.30
	3	37.44	5.81	8.96	25.35	14.75	20.61	2.76	55.58	14.39	25.82	1.19
	4	2.37	6.52	0.83	2.80	9.41	5.56	7.78	0.96	27.47	7.80	11.94
	5	0.64	0.19	0.39	0.16	0.70	1.50	0.89	1.04	0.27	9.39	1.91
	6	0.21	0.14	0.07	0.11	0.11	0.16	0.32	0.26	0.44	0.36	2.50
Total	(+2)	52.58	32.32	53.01	51.90	54.92	31.83	94.02	77.52	77.16	45.03	23.84
Total	(+3)	40.66	12.66	10.25	28.42	24.97	27.83	11.75	57.84	42.57	43.37	17.54
3	2	4.21	4.68	8.26	5.06	5.71	1.16	58.96	6.23	2.84	0.14	5.52
	3	4.27	2.17	1.99	4.03	2.73	3.87	0.82	43.47	4.85	2.18	0.09
	4	0.45	1.18	0.38	0.48	1.24	0.97	1.67	0.42	28.39	2.98	0.81
	5	0.21	0.08	0.12	0.06	0.10	0.29	0.30	0.68	0.24	15.04	0.74
	6	0.02	0.04	0.01	0.02	0.02	0.03	0.10	0.16	0.49	0.39	3.85
Total	(+2)	9.16	8.15	10.76	9.65	9.80	6.32	61.85	50.96	36.81	20.73	11.01
Total	(+3)	4.95	3.47	2.50	4.59	4.09	5.16	2.89	44.73	33.97	20.59	5.49
4	2	4.40	4.10	3.70	3.80	3.30	1.50	8.30	0.80	0.30	0.24	3.82
	3	3.60	2.80	2.40	2.70	2.80	2.40	1.10	6.20	0.60	0.55	0.19
	4	0.50	1.60	1.00	1.00	1.20	0.90	1.10	0.50	3.10	0.44	0.29
	5	0.20	0.10	0.30	0.20	0.20	0.10	0.20	0.20	0.10	1.34	0.13
	6	0.00	0.10	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.06	0.42
Total	(+2)	8.70	8.70	7.40	7.80	7.50	4.90	10.70	7.70	4.10	2.63	4.85
Total	(+3)	4.30	4.60	3.70	4.00	4.20	3.40	2.40	6.90	3.80	2.39	1.03

Table 6. Comparison of 1989 yellow perch stock size estimates (millions of fish generated by simulated projection of stocks in 1989 versus CAGEAN estimates in 1990.

UNIT	YEAR CLASS	STOCK PROJECTION	CAGEAN ESTIMATE	DIFFERENCE (NO.)	(%)
1	1987	5.54	1.32	-4.22	-76
	1986	37.18	32.43	-4.75	-13
	1985	18.89	18.29	-0.60	-3
	1984	14.01	14.21	0.20	1
	1983	1.58	1.86	0.28	18
	TOTAL	77.20	68.11	-9.09	-12
2	1987	3.05	1.66	-1.39	-46
	1986	20.83	25.82	4.99	24
	1985	5.97	7.80	1.83	31
	1984	7.58	9.39	1.81	24
	1983	0.15	0.36	0.21	140
	TOTAL	37.58	45.03	7.45	20
3	1987	5.06	0.14	-4.92	-97
	1986	0.36	2.18	1.82	506
	1985	0.95	2.98	2.03	214
	1984	7.46	15.04	7.58	102
	1983	0.06	0.39	0.33	550
	TOTAL	13.89	20.73	6.84	49
4	1987	2.97	0.24	-2.73	-92
	1986	0.21	0.55	0.34	162
	1985	0.37	0.44	0.07	19
	1984	1.33	1.34	0.01	1
	1983	1.05	0.06	-0.99	-94
	TOTAL	4.93	2.63	-2.30	-47

Table 7. Agency trawl indices and regression equations relating index values (catch per hour trawl) to estimates of recruitment (millions of recruits) for the 1988 cohort of yellow perch.

UNIT	INDEX	AGE	VALUE	REGRESSION EQUATION a	b	r^2	PREDICTED ABUNDANCE AGE-1 (E 06)	AGE-2 (E06)
1	ODW	1	11	-31.97	15.76	0.429	7.192	5.754
	USFWS-SUM	0	129	-31.63	12.53	0.328	29.360	23.488
	USFWS-SUM	1	16	-30.96	15.39	0.593	12.643	10.115
	Weighted Mean*						14.973	11.978
2	ODW	0	4	-17.21	13.20	0.470	4.035	3.228
	ODW	1	11	-62.17	22.44	0.752	2.075	1.660
	USFWS-SUM	0	129	-44.28	14.77	0.394	27.613	22.091
	USFWS-SUM	1	16	-37.90	16.92	0.619	10.038	8.030
	USFWS-FAL	1	4	-31.59	18.85	0.511	2.075	1.660
	Weighted Mean*						7.870	6.296
3	ODW	1	11	-12.31	5.27	0.398	0.785	0.628
	USFWS-SUM	1	16	-6.78	4.01	0.334	4.581	3.665
	PFC	0	40	-4.98	3.55	0.288	8.186	6.549
	PFC	1	60	-4.84	4.64	0.386	14.234	11.388
	Weighted Mean*						6.895	5.516
4	USFWS-SUM	1	16	-1.97	1.82	0.293	3.186	2.549
	USFWS-FAL	1	4	-2.93	2.46	0.356	1.029	0.823
	PFC	0	40	-0.76	1.50	0.233	4.803	3.842
	PFC	1	60	-0.97	2.07	0.383	9.480	7.584
	Weighted Mean*						4.782	3.826

* Values weighted by r^2

Table 8. CAGEAN projections of yellow perch stock size and RAH (target effort option) by management unit in 1990.

Unit	Age	Stock Number (E 06)	Exploit Rate (u)	Catch Number (E 06)	Catch Weight at age (g)	RAH (t)
1	2	11.98	0.05	0.63	87	55
	3	1.04	0.32	0.33	104	34
	4	20.88	0.58	12.19	114	1,389
	5	8.46	0.58	4.94	130	644
	6	7.43	0.58	4.34	161	698
	Total (+2)	49.79	0.45	22.44	126	2,820
	Total (+3)	37.81	0.58	21.80	127	2,765
2	2	6.30	0.13	0.81	106	85
	3	1.19	0.45	0.54	117	63
	4	11.94	0.71	8.44	128	1,084
	5	1.91	0.71	1.35	169	228
	6	2.50	0.71	1.77	199	351
	Total (+2)	23.84	0.54	12.90	140	1,811
	Total (+3)	17.54	0.69	12.10	143	1,726
3	2	5.52	0.15	0.83	117	97
	3	0.09	0.51	0.05	129	6
	4	0.81	0.65	0.53	156	82
	5	0.74	0.65	0.48	203	97
	6	3.85	0.65	2.50	294	734
	Total (+2)	11.01	0.40	4.38	232	1,016
	Total (+3)	5.49	0.65	3.55	259	919
4	2	3.82	0.12	0.47	104	48
	3	0.19	0.70	0.13	111	15
	4	0.29	0.91	0.26	120	32
	5	0.13	0.91	0.12	140	16
	6	0.42	0.91	0.36	175	63
	Total (+2)	4.85	0.28	1.34	131	174
	Total (+3)	1.03	0.87	0.88	145	126

Table 9. Comparison of population parameters associated with yield options by management unit. Yield (t), annual exploitation rate (u), and survival rate are estimated for 1990.

	UNIT 1			UNIT 2			UNIT 3			UNIT 4		
Yield Option	YIELD (t)	EXPLOITATION (u)	SURVIVAL (S)	YIELD (t)	EXPLOITATION (u)	SURVIVAL (S)	YIELD (t)	EXPLOITATION (u)	SURVIVAL (S)	YIELD (t)	EXPLOITATION (u)	SURVIVAL (S)
Target Effort[a]	2,820	0.58	0.31	1,811	0.64	0.26	1,016	0.65	0.25	174	0.28	0.57
MSY Effort[b]	1,754	0.36	0.50	1,001	0.40	0.46	744	0.48	0.39	145	0.23	0.62
Maximum F[c]	1,454	0.26	0.59	631	0.26	0.59	294	0.26	0.59	70	0.26	0.59
Optimum F[d]	850	0.15	0.68	369	0.15	0.68	172	0.15	0.68	41	0.15	0.68

[a] Target effort is defined as a 20% reduction of 1981 observed effort.

[b] MSY effort yield is derived from population simulations described in the 1985 YPTG report.

[c] Maximum F is derived from Lorantas (unpublished) yield per recruit model.

[d] Optimum F sustainable yield defined by F(0.1) derived from Lorantas (unpublished) yield per recruit model.

Table 10. Agency allocation of 1990 RAH (tonnes and pounds) for different management options.

Agency	Unit	Water Area (%)	Management Yield Options: Target Effort (t)	Target Effort (lbs x 1000)	MSY Effort (t)	MSY Effort (lbs x 1000)	Maximum F (t)	Maximum F (lbs x 1000)	Optimum F (t)	Optimum F (lbs x 1000)
Ontario	1	42.3	1,193	2,630	742	1,636	615	1,356	360	793
	2	42.5	770	1,697	425	938	268	591	157	346
	3	56.1	570	1,257	417	920	165	364	96	213
	4	55.2	96	212	80	176	39	85	23	50
	Total		2,606	5,745	1,668	3,676	1,087	2,396	635	1,401
Ohio	1	49.6	1,399	3,084	870	1,918	721	1,590	422	929
	2	57.5	1,041	2,296	576	1,269	363	800	212	468
	3	31.9	324	715	237	523	94	207	55	121
	Total		2,764	6,094	1,683	3,710	1,178	2,597	689	1,518
Pennsylvania	3	11.9	121	267	89	195	35	77	20	45
	4	17.2	30	66	25	55	12	27	7	16
	Total		144	317	114	252	47	104	28	61
Michigan	1	8.1	228	504	142	313	118	260	69	152
New York	4	29.6	52	114	43	95	21	46	12	27

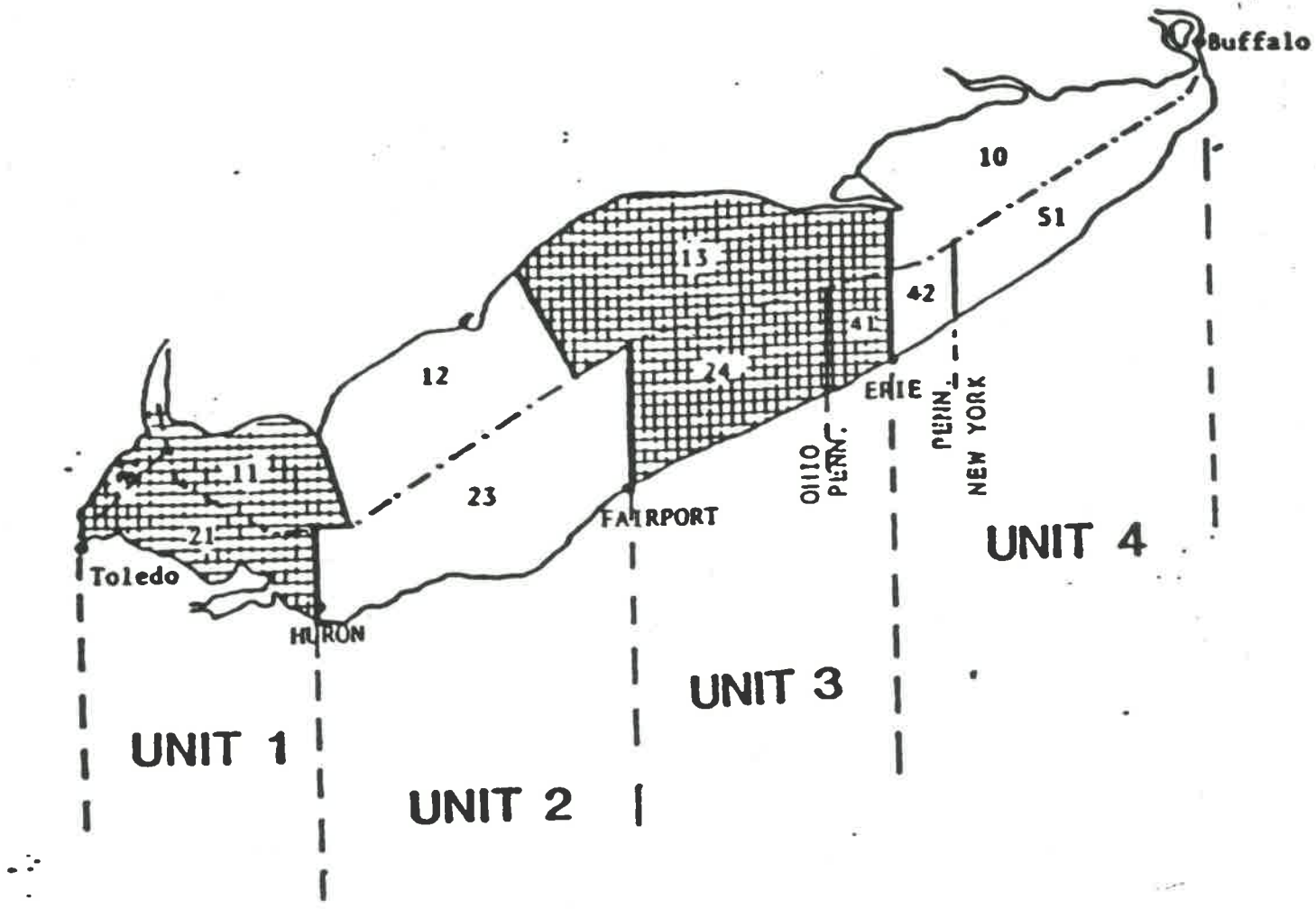
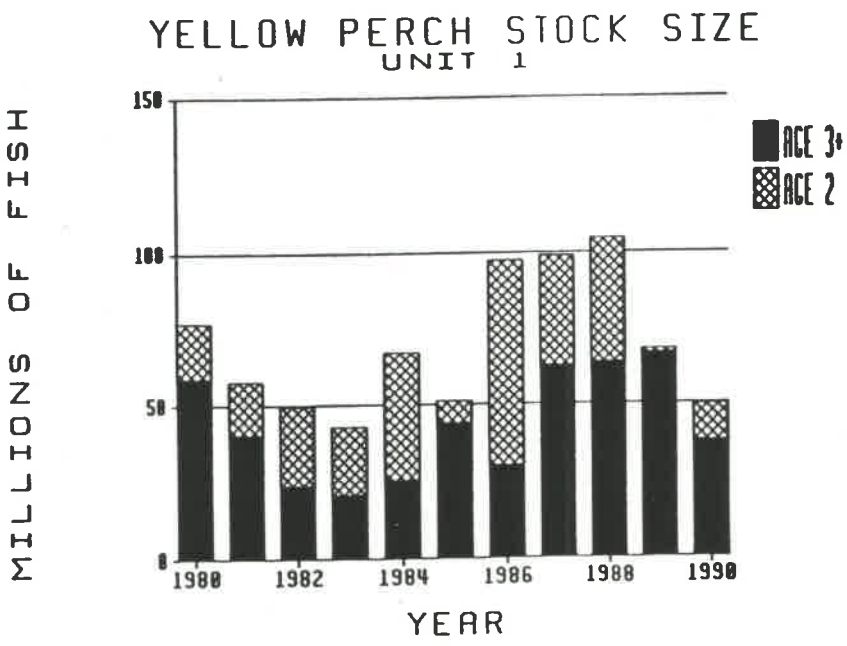
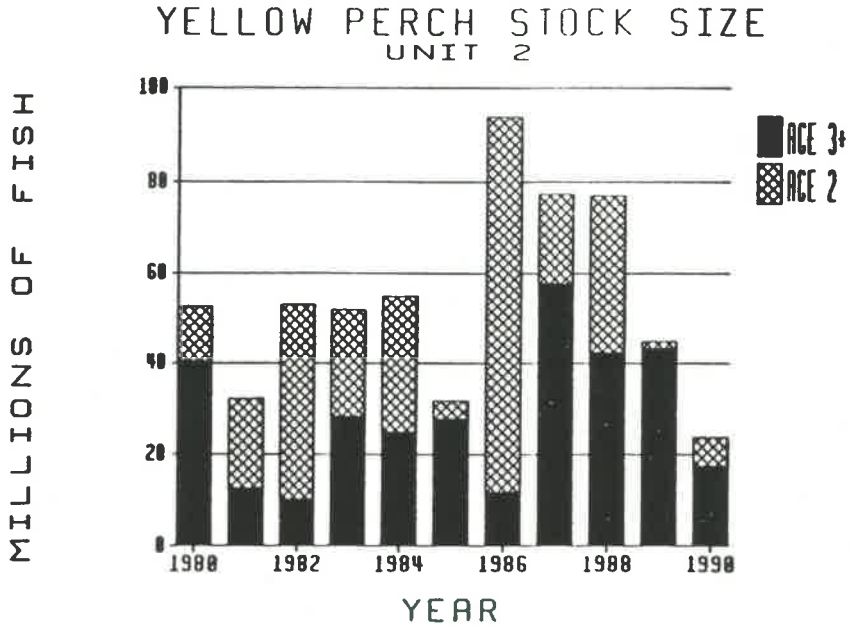
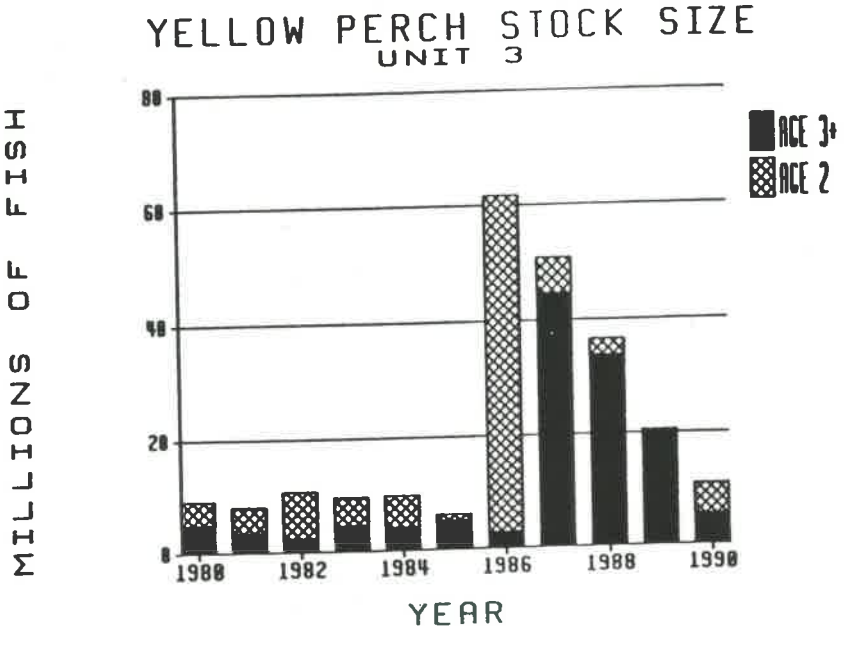
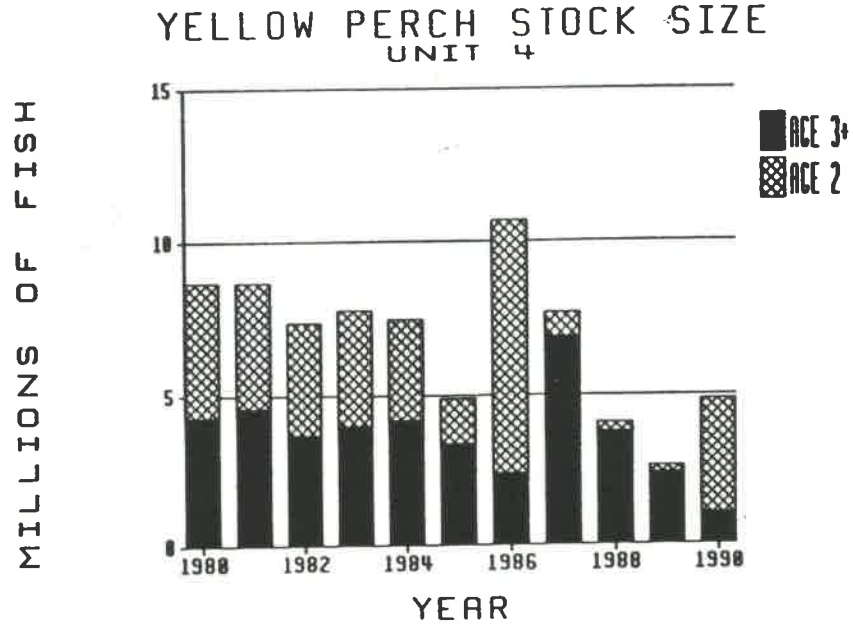


Figure 1. Geographical boundaries of mangement units for yellow perch task group.


YELLOW PERCH STOCK SIZE
UNIT 1
MILLIONS OF FISH
150
100
50
0
1980
1982
1984
1986
1988
1990
YEAR
AGE 3+
AGE 2


YELLOW PERCH STOCK SIZE
UNIT 2
MILLIONS OF FISH
100
80
60
40
20
0
1980
1982
1984
1986
1988
1990
YEAR
AGE 3+
AGE 2


YELLOW PERCH STOCK SIZE
UNIT 3
MILLIONS OF FISH
80
60
40
20
0
1980
1982
1984
1986
1988
1990
YEAR
AGE 3+
AGE 2


YELLOW PERCH STOCK SIZE
UNIT 4
MILLIONS OF FISH
15
10
5
0
1980
1982
1984
1986
1988
1990
YEAR
AGE 3+
AGE 2